M. ILYIN, E. SEGAL

DO YOU KNOW?

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WHAT THIS BOOK IS ABOUT

This is a book about the things you can find all around you.

Many of them are old friends of yours: a note-book and a pencil, a tea-cup and a knife, a shirt and a pair of shoes, a saw and a hammer, a watch and an electric bulb, the house you live in and the car that speeds down the street, past your house.

You've known all these things for a long time, and yet you don't really know them well.

You would probably be surprised if you were told that your note-book grew up in a forest and your shirt in a field, that your rubber boots are made of sawdust and your buttons of cottage cheese, that a delicate tea-cup and a clumsy great brick are close relations, that a small hail-stone can tell us which wind is blowing high up in the sky, that a toy tumbler can explain why ships don't keel over.

So you see, you really don't know your old friends after all. We wrote this book so that you can get to know them better.

When you hold a slice of bread in your hand, we want you to know how the grain was made into flour and the flour into bread. When you turn on a tap we want you to understand how the water got there.

In this book you will read about things that are close at hand, and about things that are very far away, too. We're going to take you on a boat which sails down a gigantic stairway, where the steps are made of water; we're going to steam across a man-made sea which didn't even exist a short time ago.

We're going to visit a collective farm and a city.

We're going to walk through a wonderful orchard filled with strange fruit; and then, as if someone had waved a magic wand, we shall see a mighty dam span a river.

Perhaps you'll ask who is responsible for all these wonders. And we shall tell you of the giants who built them. They look just like ordinary people, but their strength can move mountains and bring to a stand-still the waters of swift-flowing rivers.

But we don't want to tell you the story beforehand. You had better read it for yourself. We only want to say that we could not write about everything we wanted to. We have only answered some of your questions. The others we had to leave out. But we shall try to make up for this in our next book.

Just a word about how to read these stories. Don't try to read them all in one evening. To understand them better read them one or two at a time.

Some books are easy, like eating ice-cream. You don't have to chew it at all, it melts away in your mouth. Then there are others which are more like nuts—but anyone with strong teeth can crack a nut. You like ice-cream and nuts, adventure stories and books about science. And, of course, you won't be discouraged when you see that you'll have to give a little thought to this book. But whatever seems difficult this year, will be very easy next year.

THE SCHOOL SATCHEL

THE STORY OF A PENCIL

When you were still very small you would often rummage in your older brother's satchel. You would pull out his reading-book and look at the pictures. But best of all you liked the little wooden house without windows. The front door wasn't where it should have been. Instead of being in one of the walls, it was in the roof. And it was always so hard for you to open that door.

There were two rooms inside the house: one was long and narrow, and the other was small and wide. Two friends lived in the long narrow

room, a pencil and a blue pen with a shiny point. The pencil's friend, an india-rubber, lived in the little room. It liked cleanliness and that is why it was always dirty itself. If the pencil made a mistake, its mate, the rubber, would go to work immediately and straighten things out, even if it meant getting dirty itself.

There were note-books in the satchel too, and you were very curious about them. You were impressed by the even and beautiful lines, circles, and flourishes your brother had made with his pen.

Now you yourself are a schoolboy. You have your own satchel, your own books and note-books, your own pencil-box with pencil, pen, and rubber. Every day in school you learn how to write with your pen, how to steer it across the white field of paper, along the blue paths of the lines. Your pen is not always obedient. Every now and then it breaks the traffic rules. And they are very strict: it's against the rules to wander off the paths.

Sometimes it's your own fault—if there's too much ink in the pen you'll get a blot. Then your blotter has to rush in and give first-aid.

When you were just learning how to write you had ink blots of all shapes and sizes in your note-book. There would be a black lake on one page and a whole black sea on another.

A pencil doesn't make blots, because it does not write with ink. However, you haven't yet learned the rules of using a pencil. When you sharpen it, it loses almost a quarter of its length at a time. Then you drop it on the floor and the sharp point breaks, so you have to sharpen it all over again.

One pencil serves your older brother for a long time, but in your hands it becomes a tiny old stub in a week. You are just as heartless towards your pen-nib. Look, it's lop-sided already. One side of the point is broken and shorter than the other, and you might as well throw it out.

But we promised to tell you a story about a pencil.

Before our pencil could be born, a beautiful tall pine-tree grew up in Siberia. Not just an ordinary pine, but a Siberian cedar. Have you ever eaten pine nuts? They taste so good, it's no wonder the squirrels love them. Actually, it's wrong to call them nuts, because they're really seeds and they come from the cones.

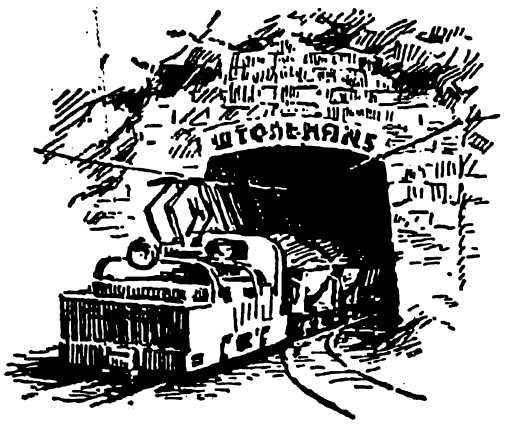
The wood of these trees is light and strong. Chests are made of it, and moths will never live in such chests, perhaps because they hate the smell of cedar wood.

But the pencils are what the Siberian cedar should be especially proud of, for they are made of its wood, and millions of school children write with them. Why is this tree so honoured? Because it's easy to cut and to plane it. If you cut a little stick of cedar wood with a knife the edges will not be rough and jagged, but smooth and even. However, a stick is not a pencil, and you can't very well write with a stick.

To change a stick into a pencil you have to put something into it which leaves a mark on paper. The best thing for this purpose is graphite. It's as black as coal—to which it is actually related. Graphite also comes from Siberia. The best and purest kind of graphite for pencils is found in places where fast rivers flow from the high mountains, over rapids, through forests and canyons. There's a ridge called Botogol in these mountains where, deep below the earth's surface, as if in an underground store-room, great quantities of shiny soft graphite lie hidden.

Trains speed from Siberia to Moscow, and they carry graphite and cedar sticks called chocks to the pencil factory. To make a pencil you need clay; not just any kind of clay, but the best there is. Such clay comes from the Ukraine. You might ask why clay is needed, since a pencil isn't a brick.

Clay is used to make the pencil's graphite centre harder and more durable. The more clay there is, the harder the pencil will write. That's why some pencils write harder than others. If there's a "B" on a pencil, it means it is soft or "black." But if there's an "H" on it, it means it



is hard. You only have to look at a pencil to know whether it is hard or soft, without even trying it out.

Wood, graphite, clay.... Do you think that's all? No, there's still more to come. In order to make a pencil you also need glue and grease. Glue is used to bind the particles of graphite together and prevent them from crumbling. Grease is used to make these particles come off the tip of the pencil on to the paper more easily. If the stick of graphite isn't saturated with grease it will write faintly and unevenly. And yet, this is not all. Coloured lacquer and a shiny metal called aluminium are needed. The lacquer is used to paint the pencil and the aluminium to stamp on the shiny lettering.

Finally, all this material has been delivered to the factory. How will all these things be made to take their right places? How will the wooden chocks be transformed into identical, smooth hexagonal sticks? How will the graphite mixed with clay and grease be put through the middle?

In order to get pencils from graphite, clay, wood, glue, grease, lacquer, and aluminium, people have to tackle the job and work hard at it, because things do not make themselves from raw materials without the help of human labour.

But how should they go about their work?

If it's all to be done by hand it will take ages, there will never be enough pencils, and they will be very expensive.

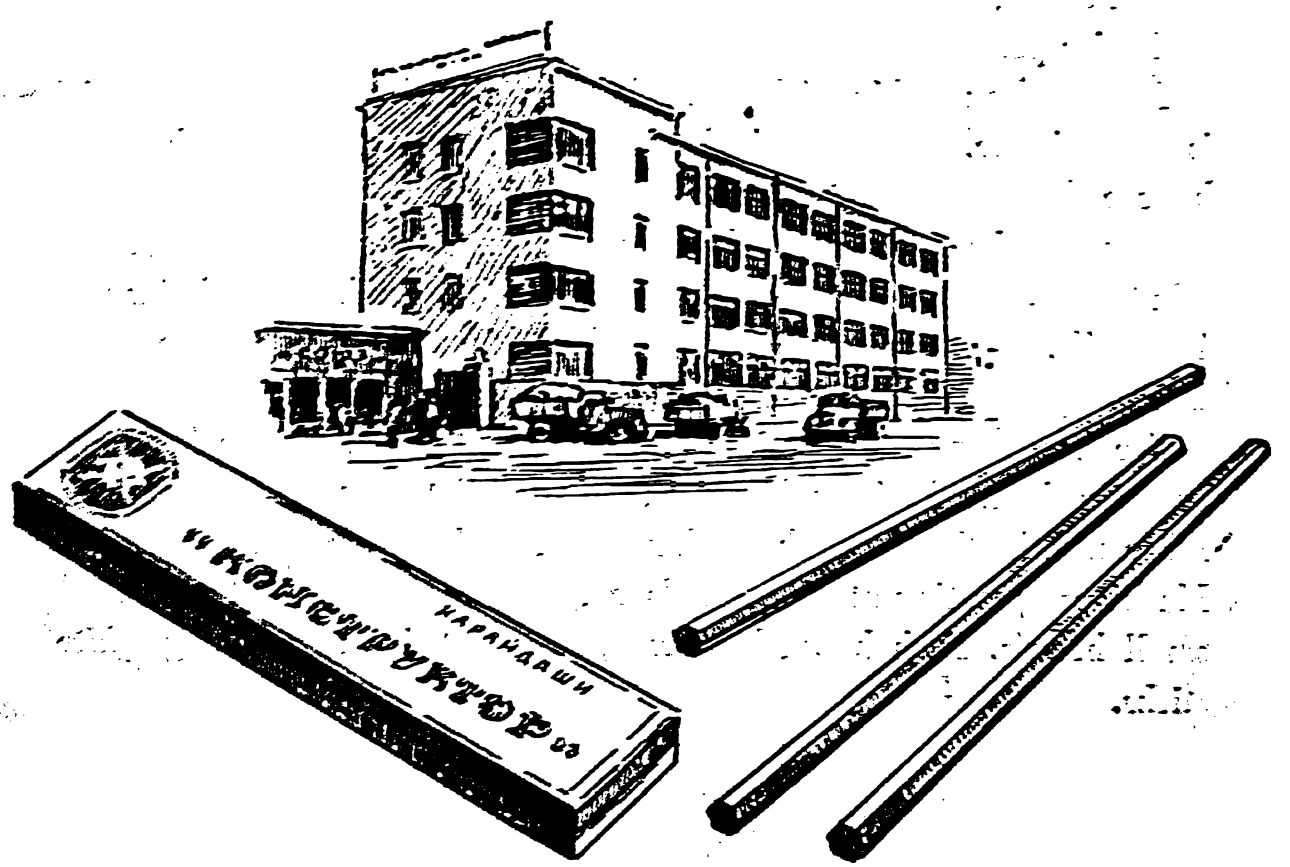
Count how many children there are in all the schools. Millions of them! And they need millions of pencils.

The work cannot be done without machinery.

You will see many clever machines if you visit a pencil factory. Their speed is so great that they produce three million pencils every twenty-four hours. If these pencils were laid end to end they would almost reach from Moscow to Leningrad.

At one end of the factory, huge machines mix the graphite with clay. And at the other end, other machines dump the finished pencils into boxes, two or four at a time, with such speed that it is difficult to keep count of them.

Clay, graphite, and wood are not transformed into pencils immediately. Their long journey through the factory from one machine to another is a continuous transformation. The clay and graphite are changed into



powder, into thick round rods called moulds, and into long black threads. At first it isn't clear why all this is necessary.

This is the reason:

To begin with, the clay and graphite have to be finely ground and mixed with glue, then ground again, this time into powder from which the graphite rods are to be made. But air bubbles and specks of dirt remain in the powder between the particles of graphite and clay. If they are not taken out, the graphite rod will be brittle and the pencil will have to be sharpened again and again.

In order to get rid of the air bubbles the powder is put under great pressure, not by hand of course, but by a huge machine called a press. And this is where the thick round rods called moulds come from.

In order to get rid of the bits of dirt the mould is pressed through a very fine sieve. The dirt stays in the sieve and the tiny graphite particles pass through the holes and come out as thin black threads. New moulds are made from the threads, but this time they are free of all the specks of dirt and air bubbles. These very moulds are then made into graphite sticks for pencils.

But how can a thin stick be made from a thick mould? Actually it is quite simple. The mould is forced through a small hole. It's hard to believe that such a fatty can squeeze through such a small door; but it does, and in doing so it gets quite thin and stretches out into a long thin thread. The thread is cut into pieces which are soft and unfit for use in pencils. They have to be dried and baked in an oven to become hard. Then they have to be saturated with grease to make them write clearly.

See how many changes the graphite goes through before it finally becomes the kind of graphite stick that goes into a pencil!

Meanwhile, the cedar chocks have been having their own adventures. Machines operating at high speeds cut each cedar chock into identical small boards. Each board has six grooves cut in it for six graphite sticks.

Finally, the Siberian graphite and the Ukrainian clay meet the Siberian cedar. The graphite sticks slip into the grooves in the little boards. Then they are covered with an identical grooved board, which fits on like a lid and both boards are then glued together.

Suddenly, there are six pencils, attached one to the other. The sextette has to be separated, so that each pencil might live independently of the others. A machine cuts the little board into six hexagonal sticks, each one of which has a graphite centre.

This rough, unpainted stick is already a pencil, although not a very pretty one. To become attractive it must go through still other machines which polish and varnish it. Then the pencil is sent to the last machine where it is covered with a shiny paper-thin strip of aluminium and then stamped and labelled.

The shining letters on the pencil spell out the name of the factory.

A pencil has been born and given a name. Now it is ready for its trip from the factory to the store, and from the store to your pencil-box.

Look at the top of a pencil. See, its two halves are glued together. This is a sign of all the changes it went through in the factory. Now you understand how difficult it is to make a pencil.

So many skilled people contributed their labour to make it possible for you to write and draw! Wood-cutters and miners in Siberia, the men who dug the clay in the Ukraine, the workers in the Moscow pencil factory. And many, many more: railwaymen, the people who built the machines, steel-workers—they all toiled to give you your pencil.

But we haven't said a word about how the pencil was invented. In olden times the pencil, as we know it today, did not exist. Artists used to draw with a silver stick and school children wrote with a stick of lead. A lead stick leaves faint grey writing on paper, and it is uncomfortable to hold as well. It used to come in a leather holder, and when the point became blunt, the leather at the end had to be cut off.

In Germany a pencil is still called a "lead stick," purely from habit.

When someone thought of using graphite instead of lead, it took a long time and much trouble before a type of graphite was found that would not be too soft. At first it was mixed with sulphur, but this made it too brittle. As soon as clay was used instead of sulphur, everything turned out well.

How difficult it was to invent all the complicated machines that make pencils! They had to help the worker, they had to be able to mix and mill, grind and plane, glue and paint.

So you see what a long history a pencil has! Now that you have learned its history, you'll probably take better care of it and treat it with more respect. Sharpen your pencil carefully, don't cut it down needlessly, and buy a point protector so it won't break the tip of its nose when it falls on the floor. If you have no cap, then see to it that the pencil rests in a pencil-box when not in use and is not thrown around carelessly.

THE STORY OF A NOTE-BOOK

Every year, at the beginning of the term, you get your books and note-books ready. But you are not alone, there are many like you in your class, and there are so many classes in your school that it's hard to keep track of them all.

There are so many schools! There are thousands of cities in our country and tens of thousands of villages, and there are schools everywhere. Millions of school children attend these schools, and all of them need books and note-books. If all these books and note-books were piled on top of each other they would make huge paper mountains.

Not all the students have been counted, though.

Some time ago two women came to a school. The younger one was carrying a baby girl, and the grey-haired one was holding a little boy by the hand.

The teacher asked them jokingly, "Why did you bring such babies to school? The girl should be in a nursery and the boy in a kindergarten."

The grey-haired woman said, "It's we who came to enroll. My friend wants to study in the ninth class, and I'll study in the seventh. Can you tell us where there is a school for adults?"

The younger woman added, "We didn't have a chance to finish school before, and so we decided to start again now."

The teacher recommended a school for adults and said, "That's a good idea! It's never too late to study. Who suggested that you start school again?"

The older woman answered, "My friend decided to a long time ago, and my daughter kept putting me to shame: 'Soon your grandson will be going to school and you never finished your schooling.'"

We mentioned this story to show you that everyone in our country is studying: some in schools, some in universities, some in technical schools, some in trade schools. And all of them, not only those like you, need note-books.

A note-book is a simple thing. But it's not so simple to make one. You probably don't even know how and from what note-books are made!

The first to start on the job is a saw. But what has a saw got to do with it? Are note-books made with a saw?

The saw cuts down a fir-tree in the woods. But what has a fir-tree got to do with it? Are note-books made from fir-trees? That's just it, they are. First the fir-tree is cut down, then its pointed crown and sharp green branches are chopped off with an axe. A note-book doesn't need fir cones and needles. Nor is the bark of any use.

Note-books are not made from cones, nor needles, nor bark, but from fir logs. From logs? But what have logs got to do with it? Logs are used for building houses, not for making note-books!

Here's where you're wrong. It's logs that note-books are made from. In order to make note-books from a log it has to be sawed up first and then chopped up into chips. But what have chips got to do with it? Chips are used as kindlings for a stove.

These chips are cooked into a pulp that looks just like porridge. Porridge from chips? Who would want to cook porridge from chips?

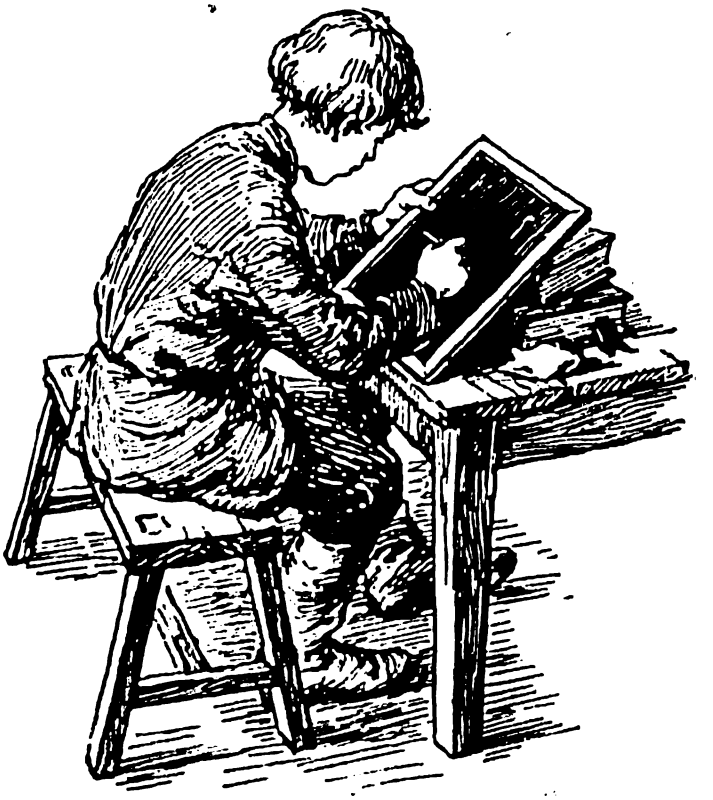
Whoever needs to, will do it. In order to cook porridge the chips are put in a kettle. The kettle is as big as a house, and the little one in your kitchen is no match for it.

Instead of oatmeal there are chips in the kettle. And instead of milk they pour acid into it. You can't make porridge from chips without acid.

The chips are cooked in the great pot and boiled down to fibres. Then the fibres are cut up and ground to make them still finer. The result is real porridge; only it is made of wood. You probably won't want to eat it as it isn't very tasty. But then it isn't meant to be eaten, for paper is made from it.

Paper from such porridge? Who could ever believe it! But if you don't believe it, you can prove it

for yourself. It's not difficult. Take a sheet of paper and try to tear off a very thin layer from the edge. Then hold it up to a light. You'll see it isn't solid. It looks just like felt, as though it were made of thin tangled fibres. These are the same fibres that came from the fir-tree when it was boiled down in the giant kettle.



Now tear the paper into shreds and soak them in water. The fibres will separate and you'll get pulp, something like the pulp they make paper from at the factory.

It's not hard at all to make pulp from paper. Just chew it up and there you are. But how can paper be made from pulp?

This is what we shall tell you about now. To make paper, the porridge has to be mixed and shaken, so that all its fibres intertwine and tangle. Then it has to be rolled out as thin as possible, just like dough for noodles. The result will be a crumbly, damp sheet of paper.

But paper must be dry and strong. That means the water has to be extracted, the wet sheet of paper has to be wrung out and dried.

What a long chain of events! The fir-tree is made into logs, the logs are made into chips, the chips are made into porridge, the porridge is made into paper, and the paper is made into a note-book.

When paper of extra strength is needed it is made of rags instead of wood. The rags are also boiled in a giant kettle but, instead of acid, alkali or lime is added. The cooked rags are ground into pulp and then made into paper.

In olden times all this work was done by hand, for they had no machines then. The rags were ground down with water in a huge stone mortar. They had to be ground for a long time to make sure the pulp wouldn't have any lumps or bits of rag in it. Then the pulp was poured into a rectangular mould, a frame with a wire netting for a bottom. They shook the frame a long time just as hard as they could. The water ran out through the mesh, leaving a damp sheet of paper at the bottom of the mould. This was carefully removed from the frame, put in a press made of a board with a heavy stone on top, and then dried in the sun.

The craftsman would shape letters from wire and put them on the bottom of the frame so that people would know who had made the paper. The paper pulp in the frame would settle over the letters in a thinner layer than over the rest of the frame. People would hold the paper up to a light and see the craftsman's name in transparent letters, which seemed to be written in water.

Sometimes, instead of letters, a special sign was used for a water-mark. Each craftsman had his own water-mark: one had a turret, another a winged lion, a third a glove, and so on.

Paper was very expensive. And no wonder, for look how much trouble it was to make it! In order to speed up the process of making paper, people decided to get the river to help them. They had the right idea, for if a river could grind the grain in a mill, it could just as well grind the rags and shake the moulds.

A long, long time ago there was a water-mill not far from Moscow. It stood on the bank of the Pakhra River and used to grind corn. A paper mill was built next to it and the miller became the paper craftsman's helper. The two neighbouring mills worked happily together: flour was carted away from one to bake bread, and the other made paper so that people would have something to write on. In the spring, the river was swollen with water and broke the dam, destroying the paper mill. Another one was built to replace it, this time on the River Yauza.

When Leningrad was built (it was called St. Petersburg then), they began making paper there too. As soon as the paper mill in St. Petersburg started working, Tsar Peter I had the news spread to the people. A town crier and a drummer were sent through the streets. The drummer beat out his summons. When the people gathered round, the crier announced in a loud voice that by royal decree a paper mill had been built behind Galley Yard, and that paper was for sale at the Admiralty, where the ships called galleys were built.

The paper was thick and strong. A design of anchors was used for the water-mark, just like the arms of the new capital, but the paper was so expensive that only a few people could afford to buy it.

It's no wonder then that school children had no note-books in those days. Still, they managed to write. When a boy went to school he took along a slate-pencil and a slate made of a smooth thin layer of black stone.

You only write on a blackboard in school and it's a large one, one blackboard for the whole class. But before, each schoolboy had his own little blackboard instead of a note-book.

It wasn't a very happy arrangement, for as soon as the little blackboard was covered with writing, it had to be wiped clean so that it could be written on again. One couldn't very well look back to see what lessons had been learnt yesterday or the day before.

Paper is quite another thing. It stores up everything that is entrusted to it. On paper, as the old saying goes, what's written with a pen can't be chopped out by an axe.

Only when paper became cheap could every schoolboy have his own note-book. And it became cheap when huge machines for making paper were invented.

There are huge paper factories where machines help man in every way. Machines are used from the very beginning, when the fir-tree is still growing in the forest. An electric saw cuts down the trees in the

forest. A timber carrier takes the logs to the river, where they float down with the current singly and in rafts. When they finally reach the factory piers they are hauled out of the water and stacked on the shore by a huge machine called a cable crane.

Then they are delivered to the factory. There other machines go to work on them. A mechanical saw with many blades saws them into pieces, a bark-stripping machine strips the bark from them, and a hogging-machine chops them into chips. The chips are then stacked in kettles and cooked. When it has been cleansed of foreign matter and bleached, the wood pulp goes through a machine which crushes and grinds the fibres. Finally, the paper pulp goes to the last machine.

You have never seen a machine as big as this one in your life. The difference between this machine and an ordinary room is like the difference between an elephant and a bird cage. If you stand at one end of it you can't see the other one. And no wonder, for many machines make up this one machine, and each one does exactly as it is told: one shakes a mesh and tangles the fibres; another extracts water from the paper and sends the paper on further; a third one also has its heart in its work as it irons and smooths out the paper between hot rollers to make it completely dry and flat. At the very end the ready paper is wound round a spool into a tremendous roll. The operator knows that the faster the paper ribbon runs through the machine, the more paper there'll be for school children and students. We all work together in our country and if everyone saves time, the Soviet Union will go forward even faster and will become richer and stronger from day to day.

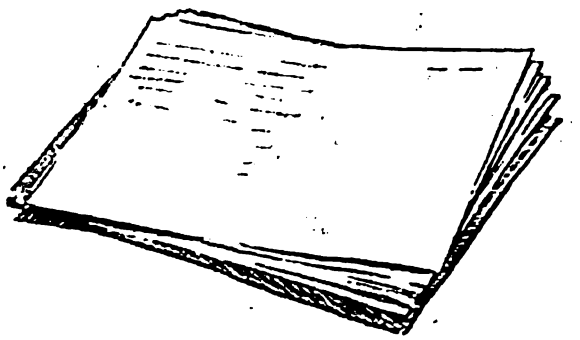
When the operator presses a button, an arrow indicating the speed jumps to the right. The paper ribbon whizzes by at 273 yards per minute. This means that every minute the machine produces 273 yards of paper.

The huge machine hums louder and louder. Blue crackling electric sparks fly up from the paper ribbon. The roll of paper on the spool at the end of the machine grows bigger and bigger, like a rolling snowball.

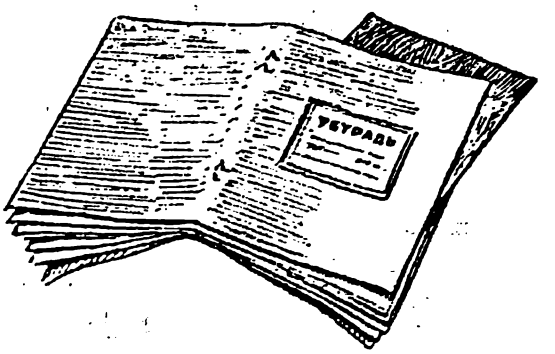
The operator wonders whether he can speed up the machine still more. He presses the button marked "Faster." The arrow in the measuring apparatus moves still farther to the right. Soon it will reach the red line marked "299 yards"! It can't go any further, because the paper ribbon will start tearing and the motors will break down if the machine is made to work still faster.

After work the operator and his co-workers get together and discuss ways in which to alter the machine and make it go beyond the red line.

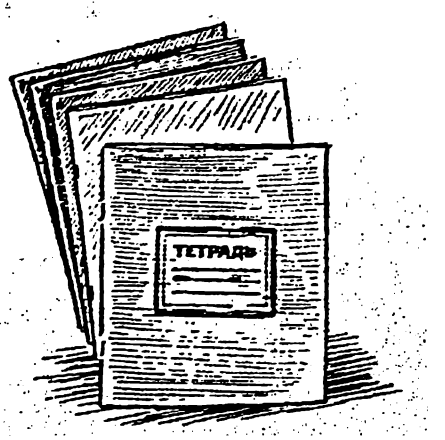
Were they able to cross the barrier of the red line?. Yes, they were. There are machines now which work at a speed of 383 yards per minute, and even faster.



A roll of paper is not quite a note-book. It can't even be moved. And then, how would you write on it? If you started unrolling it, you could paper the whole street from your house to school: you'd be able to walk to school on a paper street if you wanted to! It has to be cut into sheets, lined, sewn together, and put between covers before it's fit to be written on.



There's no sense in doing all this by hand, for although paper is cheap, a hand-made note-book would be very expensive.



Once again, machines are needed. Machines that make note-books for school children like you have also been invented and are working at full speed.

A paper factory is usually built in a forest region, near a big river. There's a huge paper factory near the Kama River, for instance. Note-books, however, can be made in any city, even in the flat country of the steppes, where there isn't a single tree. From the paper factory the rolls of paper go to the note-book factory by rail in covered goods waggons to prevent them from getting wet.

At the paper factory the rolls of paper are the finished product, but at the note-book factory they are the raw material. First of all a cutting-machine cuts them into sheets. Then a note-book machine goes to work on them. This is really a Jack-of-all-trades. When you watch it working you somehow feel that it understands everything. If a note-book is to be used for arithmetic, the machine lines the paper across and down. This is how squared paper is made. The machine draws single lines for older pupils and groups of three slanting lines for the younger ones.

The machine lines the sheet of paper on one side, then turns it over and lines the other side. Next, it cuts the large sheet into smaller ones and counts off six sheets. And it never makes a mistake, as if it had been taught to count.

As soon as six sheets have been stacked it pushes them further on. A cover rushes up towards them. It has also been made out of paper by a machine. The cover slides on to the sheets, but this is still not a note-book. The cover and six sheets inside it have to be folded in half, for the sheets come out double in the machine, like they are if you open your note-book in the middle. The note-book machine can do anything: it can line and fold and cut. But it hasn't been taught how to sew. Another machine on another floor of the factory stitches the note-book together. There are many sewing-machines there.

The sewing-machine you have at home sews with thread. Those at the note-book factory sew with wire. As soon as the machine is started it punches holes in two note-books at a time in four places each and

stitches them together with four shiny staples. You have seen these staples many times before. They hold the sheets together. And when you want to tear out the middle page from your note-book and make a paper aeroplane, the staples hold the paper tightly. It's as if they were saying, "Hands off! Don't spoil your note-book!"

The note-book factory works from morning till night. It can make more note-books in a day than a whole school can use in half a year or even in a year.

And so, here is a clean new note-book on the table in front of you. It lies quietly and says nothing of how it was once a fir-tree and how a squirrel jumped from branch to branch on it. The note-book can't tell you how the fir-tree floated down the river, how it was cooked in a kettle, how it went through all the machines, how it crossed the whole country. The fir-tree had many adventures before it turned into note-books like this. And now the note-book's fate is up to you.

You can copy good poems into it in a clear, even handwriting and your silent note-book will talk in rhyme. It will recite what you wrote to anyone who picks it up. It will help you to work well at school, to read and to write and to learn a lot of things.

THE STORY OF A PENKNIFE

Every schoolboy dreams of a shiny new penknife.

Of course, there are all kinds of knives. There are very plain ones, with only one blade. There are also knives that have a corkscrew, a screwdriver, and a file besides the two blades. If you have a knife like that they will always be asking you to give a hand around the house.

Father has to fix a socket. Where's the screwdriver? In your penknife. Mother has to open a can. Where's the can-opener? In your penknife! It's not a knife, it's a Jack-of-all-trades!

Even the simplest kind of knife with only one or two blades is not a bad worker. It can sharpen a pencil, it can cut branches for a bonfire, it can peel potatoes. In skilled hands it can make a ship from a board, or a whistle from a reed, it can cut a branch off a tree and carve an intricate design in the green bark.

A knife has to work hard for man, but man had to work hard too before he invented the knife. There isn't a single craftsman who could make a knife by himself from beginning to end. A knife is made by dozens of people. Miners mine the ore. Blast-furnace workers smelt cast-iron from the ore. Steel-makers make steel from the cast-iron. Metal workers make blades from the steel. They all work in different places and never even see each other. But they all work towards the same goal: one starts the job, another picks up where the first one left off, and a third finishes it.

In the Urals there is a mountain called "Magnitnaya." Day and night the sound of blasting there is like cannonade. The miners are dynamiting the shiny rock called ore.

Huge machines rolling on caterpillar tracks move on mountain slopes. Each machine has a long arm which ends in a huge dog-toothed iron scoop.

The excavator-operator sits in a little cab. He pulls one lever, then another. And the excavator obeys him and turns to the right or to the left, lowering or raising its long arm. Turning to one side, it scoops up the iron ore and carries it to a railway waggon standing near by. The operator changes levers, and the bottom of the scoop drops open as if the machine were opening its great jaws. The ore falls into the goods waggon and the excavator turns back to scoop up some more.

Finally, the waggon is filled to the top. The electric train rushes the waggons off to the factory. There tower-like blast-furnaces as tall as ten-storey houses stand in a row.

The goods waggons dump the ore into an enormous funnel and from the funnel it goes into tubs, which automatically roll up an incline to the very top of the furnace.

One after another the tubs climb to the top and dump everything the blast-furnace needs into it: pieces of ore, calcium carbonate and pieces of coke as black as coal, because they are actually made from coal. Both the coke and the calcium carbonate are needed to help the blast-furnace smelt cast-iron from the ore.

The heat inside the furnace is so great that even a stone turns to liquid. If you peek into the furnace through a little mica-covered window, you can see the white-hot pieces of coke and the trickles of flaming metal running down them. Every four hours a worker presses a button and a powerful pneumatic hammer breaks through the clay plug which stops up the hole near the bottom of the furnace. Then a blinding stream shooting fiery sparks suddenly rushes forth towards a channel prepared

for it. It looks like a river of liquid fire. But this isn't fire, it's molten metal, it's cast-iron. The fiery stream from the furnace pours into a huge scoop on wheels. An engine backs up and takes it to the foundry shop.

Then the hole in the furnace is plugged up again. A worker presses another button and an electric cannon fires a big lump of clay into the hole, sealing it completely.

The cast-iron is taken to the open-hearth furnace where the steel is made. There's a little window in this furnace, just like the one in the blast-furnace. If you peek through it your eyes will hurt. There, in the furnace, is a fiery lake ruffled by fiery waves, and the whole furnace glows from the bright flame. All kind of scrap iron is thrown into the fiery lake: machine parts, rusty wheels, rails, girders.

Once, an old wheel was lying on a dump. It looked as though it would never be of any use again. But it found its way to the factory and was thrown into the furnace. And it was dissolved in the molten cast-iron together with the rest of the scrap iron, just like a lump of sugar in a cup of tea. And so, what seems like the end for some things, is really a beginning for others.

Shining new resilient steel will be founded in the furnace from cast-iron, ore, and scrap iron. Many things will be made from the steel: knives, axes and saws, rails and girders, machines and machine-tools.

However, there's still a long way to go from newly founded steel to a penknife.

The molten steel has to be poured into moulds. When the steel cools, ingots are formed. These ingots have to be heated till they are red-hot and then rolled out like dough with a rolling-pin. This is done on enormous machines called rolling-mills. The red-hot ingot is sent through two revolving rollers. These rollers are just like rolling-pins, only they're made of steel instead of wood and are very big. After the ingot has been rolled back and forth several times between the rollers it becomes flat. Another rolling-mill transforms the flat ingot into a sheet.

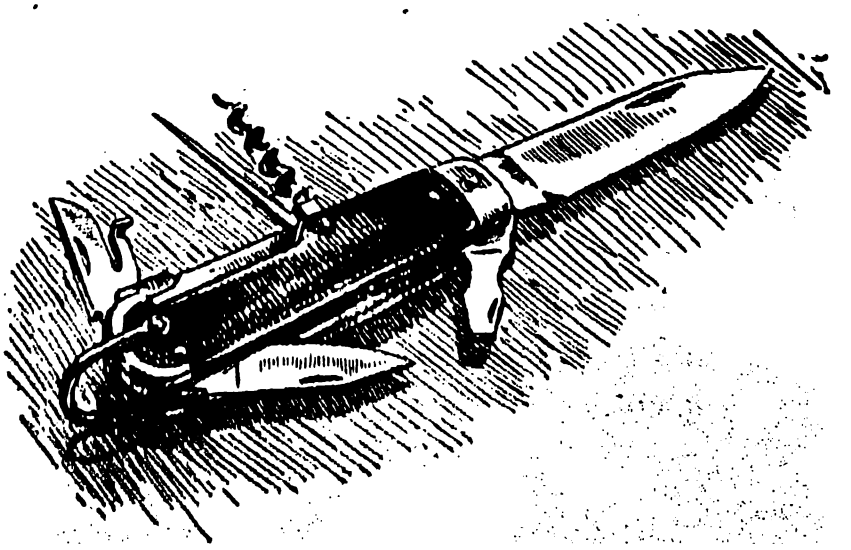
At home you cut paper with your scissors. At the factory there is a scissors-machine which cuts steel. The sheet of steel is cut into strips and the strips are cut into pieces. None of these little pieces resembles a penknife as yet. Its edges are dull. It can't even cut paper, much less a twig. In order to make a knife from this little piece of steel it has to be given an entirely different shape.

In olden times blacksmiths forged knives and swords in their forges. A piece of steel was heated red-hot to make it pliable. Then the blacksmith picked it up with pincers and placed it on the anvil. A helper, the blacksmith's striker, was all ready with his heavy sledge-hammer. The blacksmith himself had a small hand-hammer with which he pointed out the spot to be hit, and his striker's sledge-hammer would hit the spot with a mighty crash.

"One!" the hand-hammer would hit.

"Two!" the sledge-hammer would boom in answer.

The red-hot piece of steel would flatten out to the right shape.



It was hard and tricky work. It's not so easy to make a blade from a piece of steel.

Nowadays such work is done by a machine. One machine takes the place of both the hammer and the anvil. A flat piece of steel is placed on an anvil, into a groove the shape of a knife. When the blacksmith turns on the machine the sledge-hammer drops down and hits the piece of steel with a mighty blow, causing it to spread in all directions and fill out the groove. There's a groove in the sledge-hammer too. When the piece of steel is squeezed from all sides there's only one thing left for it to do, and that is to take on the shape of the groove.

This is where they run into trouble. When the steel finds itself squeezed into the groove it starts spreading in all directions, as if it were trying to find a way to escape. And it does, for it creeps out along the edges and into the space between the hammer and the anvil. This means that the edges of the blade are rugged and they have to be trimmed. The blade then has to be tempered to make it firm and hard; that's why it is heated to a high temperature and then quickly cooled. It might turn out too hard and brittle and break when in use, and this mustn't happen. In order to make the knife both hard and flexible it has to be heated again, though not as much as before, and then cooled gradually.

You can see what a knife must go through so that it can face any obstacle without bending or breaking.

But even this is not all. The knife has to be ground smooth on a whetstone and polished to a high gloss with emery.

Finally, the blade is ready. It needs a second smaller blade for a mate, as well as a corkscrew and a screwdriver. They all need a case made of two steel plates to hold them together. They also need two pins on which the blades, the corkscrew, and the screwdriver will fit as on an axis. If you want to, you can put a blade in its house, or you can take it out.

If the blades are to obey you and not pop out when they shouldn't, there must also be two springs. When you snap the blade shut it will stay locked in until it's called on to work.

The parts are all finished, they now only have to be assembled. Separately they're not of much use, but all together they make a penknife.

Is this the end of the story of a knife?

No, it's only the beginning.

You and your penknife will be in many a tight spot together! Some day you might take it on a long journey where it will help you build a tent and make a fishing-rod or leave marks on the trees to guide you back to camp again. At home it will also be your faithful friend and will be with you always, either in your pocket or your satchel.

It can help you in all sorts of ways, but you must take good care of it. Dampness is bad for it, it makes the knife sick, covering it with rust. Give your knife work it can do. Don't make it cut iron, there are files and saws for that. Don't dig with it, for if it hits a rock it will break. Don't carve your school-desk with it. Remember that craftsmen made the knife for work and not for spoiling things. If you take care of your knife and protect it, it will repay you with honest work.

THE STORY OF THE PEN AND INK

Every day you go to school and write out problems with your pen, but have you ever stopped to think where it came from? Or where your ink and your ink-well came from?

There was a time when all pens came from geese, and when no one had ever heard of green or red ink. In one of Krylov's fables, the geese

boast that their ancestors saved Rome. It's hard to say whether they were telling the truth or not, but there's another thing for which we are indebted to them: our ancestors wrote with goose quills for hundreds of years, and many good books were written with them.

If you take a goose quill, dip it in ink, and then try to write with it, you'll only make a mess. How did people write with them before? Well, the quills were sharpened first—and this is where the knife came in. Have you ever wondered why your penknife is called a *pen*knife, and not a *pencil*knife? You don't sharpen pens with it, do you? You sharpen pencils with it. Sometimes words live on long after the things they were names for have changed completely, and that's what happened to the word "penknife."

In olden times a penknife was used to cut off the point of a quill on a slant and shape it. The point was slit in the middle to keep the ink from running out of it and on to the paper whenever it felt like it.

Your steel pen-nib is made the same way. It's curved to make the ink stay on it. When you press down on it, the split end separates and lets the ink flow on to the paper along the little crack. All you have to do to draw a heavy line is to press down on the point a little harder. Then the crack is widened and more ink flows on to the paper.

You never have to sharpen your pen, because it's already sharpened when you buy it. In olden days people used to spend a lot of time sharpening their pens. It wasn't easy, for it took quite a bit of skill to split the quill exactly down the middle and then make both sides the same size. The pens would get dull very soon and would have to be thrown out. That's why there was always a supply of new quills beside the ink-well. There was also a sand-box filled with fine, dry sand.

Do you know why?

When someone had filled up a whole page with writing, he'd sprinkle it with sand to make the ink dry faster. Then he'd blow the sand off the page and start a new one. The sand would often get into the envelope

together with the letter and then it would rustle whenever the envelope was picked up.

The ink wasn't at all like the ink we use today, and the writing would come out brown, as if the words had been written in strong tea. It took some time for the writing to turn black and legible.

In olden times ink was made from the juice of poisonous oak-apples. Actually, they are not really apples at all, and have no right to be called so. They are little black balls which grow on the leaves of oaks and other trees.

The ink-maker had many things in his shop besides the oak-apples. There were jars of beautiful green crystals, and the labels on the jars said: "Iron Vitriol."

First, the ink-maker would boil the oak-apples in water, and then add some of the green crystals that had been dissolved in water. The liquid would turn black instantly and become ink. To make the ink less watery and prevent it from spreading on the paper, he'd then add glue to it.

That's not how they make the ink *you* write with. This is made from dye in a huge chemical plant, and not in a little shop. When you write something on a piece of paper, you don't have to wait for the ink to get dark, because it comes out dark as you write with it.

The dye is dissolved in water and glue is added to make the solution less watery. Acetic acid is added to prevent the ink from getting mouldy in the bottles, because acid kills the mould.

Long ago, the ink-maker did everything by hand, and that's why his hands were always black with ink. Now machines help people: a mixing machine mixes the ink in vats and a bottling machine pours it into bottles.

The chemical plant makes dyes in all sorts of colours.

"What do they make dye from at the chemical plant?" you ask.

Blue dye is made from pitch-black coal.

What about green dye?

Green dye is made from pitch-black coal too.

Well then, what about violet dye?

Violet dye is also made from pitch-black coal.

How can green and blue and violet dyes all be made from coal, and from pitch-black coal at that?

The chemists are the people who can do this, and they can do even more amazing things.

The first to start on the job are the coal miners. They dig the coal in deep mines. Railwaymen deliver the coal to the plant. There, the chemists make black tar from the black coal, and then a colourless liquid that looks like water.

Chemistry is a wonderful science: it can make something that is black colourless and something that is colourless full of colour.

In olden times, ink dye was produced from plants, but now the dyes are made artificially. Once people had to get their pens from geese.

Nowadays they are made in factories. There is ore in the earth and steel is made from the ore. The steel is rolled into thin sheets and sent to the pen factory, where it undergoes many changes.

One machine cuts steel sheets into strips; another punches small pieces out of the strips. When the long strip becomes full of holes it's of no use any more and is sent back to the steel-makers to be melted down. Pen-nibs are made from the little pieces that have been punched out of the strip. Each little piece of steel looks like a pen-nib, but you can't write with it. It's flat and the ink will run right off it; therefore, it has to be curved to make a drop of ink stay on it. The tip has to be split to make a tiny crack—a little path for the ink.

All this is also done by machine, because it's quite impossible to sharpen and split the tip of the steel point with a penknife.

Then the finished pen-nib is heated red-hot in an oven and plunged into cold water or oil to harden it. After that the rust is removed and it is plated with nickel to prevent it from ever rusting again.

All this is done very quickly. Crowds of little pieces of steel travel from one machine to another, changing all the time, until they have finally become shiny pen-nibs, stamped with the factory trade mark. All these machines have been invented to make it possible for you to write with a steel pen-nib instead of using a quill.

The Union Factory in Leningrad makes so many pen-nibs in a day that there are enough and to spare.

Instead of a sand-box you have a special piece of paper that dries ink. A blotter will dry up an ink blot of any size, even though it gets all damp itself.

We nearly forgot your ink rubber! Long ago, rubber was made from the juice of rubber-trees which only grow in some tropical lands. But now wood-alcohol is made from sawdust, and rubber is made from this alcohol or from oil.

People no longer have to hunt in woods and fields for everything they need. They have learned to make pen-nibs without getting them from geese; ink without using oak-apples; and rubber without having any tropical trees around.

If a schoolboy of olden times could have a look inside your desk or your satchel he'd be startled to find a pen-nib that wasn't made from a goose quill, a graphite pencil instead of a slate one, a note-book instead of a slate, a blotter instead of a sand-box, blue ink made from black coal, and a rubber made from sawdust.

But he would really be amazed if he saw a fountain-pen. Just imagine—a pen that doesn't have to be dipped in an ink-well every minute; a pen that has its own ink-well in its tummy. When you dip it into a bottle of ink it starts drinking the ink straight from the bottle! How can it drink? It's not alive!

The answer is simple.

The ink-well inside the fountain-pen is made of rubber and is just like an eye-dropper. When you fill a pen, you press the air out of the little rubber tube, and when you let go, the empty tube straightens out and the ink is drawn up into it.

What makes the ink go up into the rubber tube? The pressure of the outside air on the ink in the bottle forces some of it up into the empty tube.

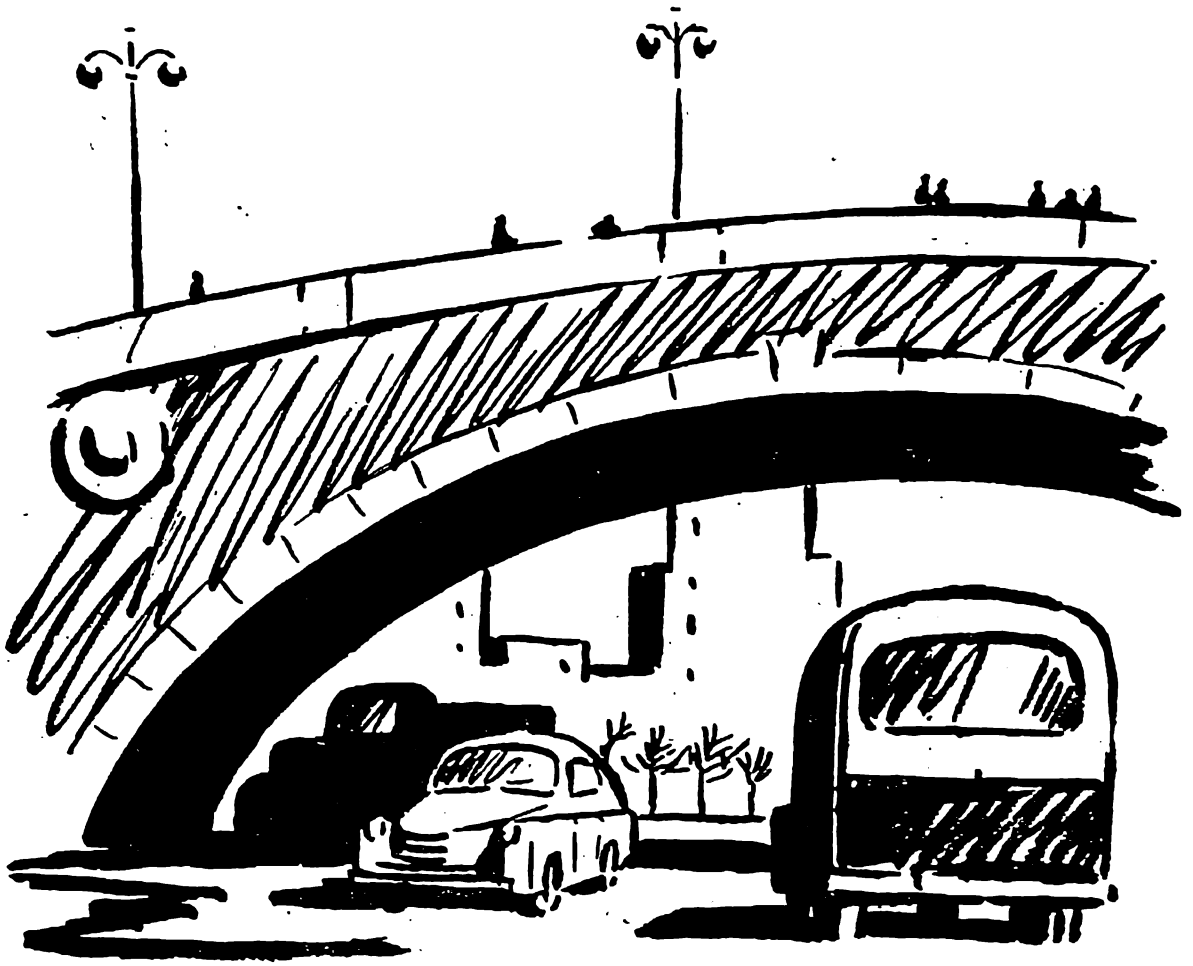
Look into your satchel once more. All your old friends are there: a note-book, a pen, a pencil, a rubber, and a penknife. Now you know

them much better than before because you know how far they had to travel before they landed in your satchel.

They came from everywhere and have changed so much during their journey that it's even hard to tell what they were made from.

Who was responsible for all these changes and started these things off on their long journey to your satchel? People of many trades, from all over the country, made this possible. The things that surround you at home, in school, and in the street are all made by the work of man.

ON A CITY STREET



HOW OUR STREET WAS BUILT

Our street is a nice one. Even though it's on the outskirts of the city, it's as good as any street in the centre. The houses are tall and beautiful. There are playgrounds, trees, shrubs, flower-beds, and benches in the big court-yards around them.

The biggest house in our street is number 7-17, although number 1-5 is quite big too. These numbers are painted on white discs and hung under blue lamps, and they have an interesting story to tell if you understand their language.

Usually houses are numbered consecutively. The odd numbers are on one side of the street—1, 3, 5, 7, 9, and so on. And the even ones on the other—2, 4, 6, 8, 10. But all our houses have double numbers: 1-5, 7-17, 19-25.

How did this happen?

It's a long story and will take some time to tell.

Some years ago there were little wooden houses where the big new houses now stand. Those little wooden houses had been in this world a long time, and in their old age they found it increasingly difficult to be of service to the people. In one of them the walls were very rickety, in another the roof had collapsed and could no longer fight the rain and snow. The porch of a third house had rotted away and people had to jump over two steps to reach the third. The children didn't mind this at all, but the grown-ups complained, "You can break your neck here!"

If you talk to some of the old-timers, they'll tell you what a hard life the people had who used to live in the little wooden houses. The main streets in the centre of the city were the only ones which had well-built houses with airy rooms, electricity, and running water. Flats there were very expensive and the workers could never afford them.

On the main streets one could often see little green cards in the windows and on the gate-posts. That meant there was a flat to let there.

The houses in our street were so overcrowded that there was no room to breathe. Two families living in a cubby-hole would be separated from each other only by a flimsy cotton curtain. Sometimes it was even worse. If there were four corners to a room, there would be a tenant in each corner. It was noisy and stifling.

The children in those houses grew up pale and thin. There was no place for them to play: the yards were filthy, and a horrible stench came from the open garbage pits. The streets were unpaved and in the autumn it was impossible to cross them. Water had to be carried up from the river in pails slung on a yoke, and it was so easy to slip on the muddy

bank and spill it. There was no question of electricity. In the evenings people sat around a tin kerosene lamp, which gave off more soot than light.

That's how things were in Russia in the times when the manufacturers and landlords were in power. They were the people who lived in the houses and villas in the centre of the city. But the Russian workers became their own masters and began to rebuild the cities, so that everyone who worked could live well. Many cities have changed so much that it's hard to recognize them.

When people who have been away from Moscow for a long time return, they can't believe their eyes. Tall new buildings are springing up all over the city like fairy-tale towers. In the evenings huge fiery triangles burn high up in the dark sky. At times they begin to move and turn slowly to the right or to the left. Beneath them torrents of blinding sparks and flashes of lightning light up the windows of neighbouring houses with blue light.

What's going on there?

Giant buildings are going up.

The fiery triangles are really the electric lights on the arms of cranes.

A crane hoists up the steel supports and girders and moves up higher and higher itself as the steel framework of the future building grows taller. The blue lightning flashes out when brave people with skilled hands weld the steel girders together at great heights.

If anyone wants to have a look at the steel skeleton he'd better hurry, for it won't be visible at all after it's clothed in brick. The brick walls grow higher and higher between the supports. Later on, the brick on the outside of the building will be faced with decorative stone slabs.

Moscow is being rebuilt according to a general plan drawn up by architects commissioned by the Soviet Government.

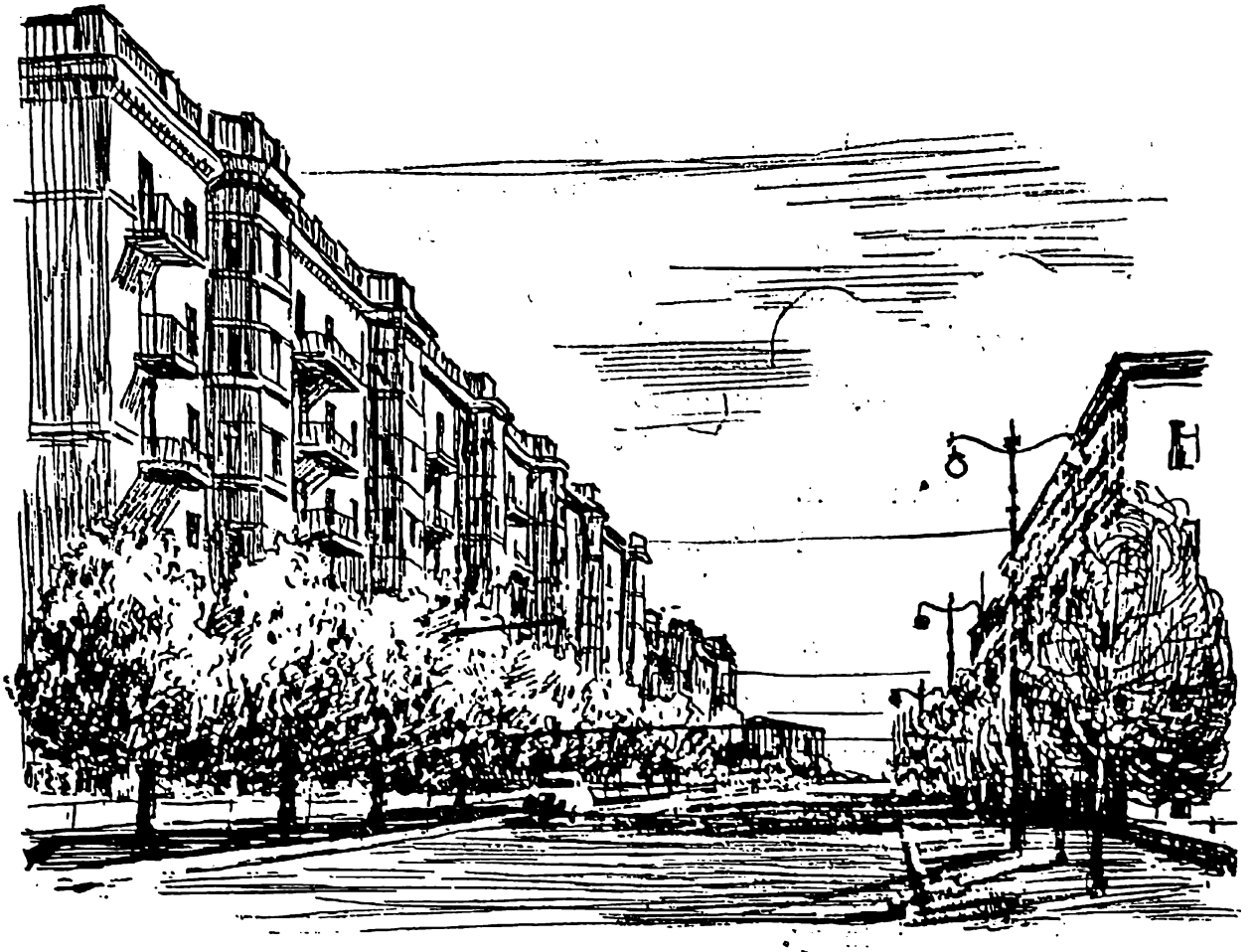
New wide streets with tall buildings, shady trees and pavements as smooth and as clean as the floor in your house have replaced the crooked little lanes and alleys. It's not easy to rebuild a huge city which grew up

over many centuries. But with each passing year there are fewer and fewer of the little old houses left. One day it was our street's turn.

You were still very young and don't remember how the workers came and built all the big houses in two years. It was interesting to watch them work.

The first ones to start were the labourers. They dug pits for the foundations, for you can't put a house up right on the ground. A house is a heavy thing and the ground is soft. If you start building a house without a foundation it will begin to sink in in a lop-sided kind of way. It will sag and crack with time. A construction job like this will always end in ruins.

To prevent this from happening, a house is built on a foundation, on a firm base of brick, large stones, or artificial stone called concrete. The builders have to put a lot of thought into the foundation. If it's too



narrow it won't be able to support the house. But it's not enough to have a broad foundation. It has to be dug deep and have its base on the lower layer of solid compressed earth, not on the upper layer of loose earth. This upper layer is very unreliable, for it often contains rain-water or water from melting snow. During the first frost of winter the water in the earth turns to ice, and the ice begins to push the foundation out, making the whole house shaky.

The builders know all this, and that's why they dig the foundations so deep. They must give every wall a reliable stone base laid on solid, dry ground.

Long ago construction workers used to dig with spades. When the earth was too hard and rocky for spades, they had to use picks and crowbars. It was hard work and took an enormous amount of time, especially if a large house was being built. Nowadays a powerful machine called

an excavator helps the workers. When the houses in our street were being built an excavator scooped the earth out of the pits with a kind of shovel that no one ever dreamed of before. It's a shovel with teeth. It bites into the earth with its steel teeth, takes up a mouthful and dumps it into a waiting lorry. It's a cinch to work with a shovel like this. As soon as a full lorry drives away, an empty one pulls up to the excavator. All the workers had to do was to smooth out the sides of the pit and keep the bottom even.

They completed their work in no time, moved on to the next sector, taking their powerful excavator with them, and began digging pits for the second house.

Meanwhile, the concrete-layers got to work on the foundation of the first site. They had brought a powerful machine called a concrete-mixer with them and it knew how to make artificial stone called concrete. It made it from a grey powder called cement, from sand, and from gravel. The concrete-mixer mixed all this together with water until it was a dough-like consistency.

Stone is supposed to be hard. There's even a saying: "as hard as a rock," but newly-mixed concrete is so soft that it can be made to take on any shape at all. For instance, if you fill a wooden box with concrete and leave it to harden, you'll get a stone slab exactly the shape of the box.

There's really nothing to explain. Remember how the sand pies you used to make always came out the same shape as the moulds? The sand pies had a short life, and then they fell apart. But a concrete slab gets harder and harder as time goes by.

You would have seen this at once if you had watched the concrete-layers work in our street. They built a huge wooden mould for the foundation and filled it with concrete. Then they moved on to the second site, where the labourers had already prepared the foundation pits. The concrete-layers went to work on the foundation of the second house, and the labourers moved on to the third site.

And so the construction workers went along the street, following in each other's footsteps. First came the labourers, then the concrete-layers, and then the bricklayers. The bricklayers also brought a helper along. And what a helper! It was higher than a ten-storey house. It only had one arm, but this was 20 times longer than a man's arm. It could lift 400 bricks at a time, or a stairway of 12 stone steps, or a whole partition weighing 15 tons.

This giant is called a tower crane. It has a little glass cage in the middle where the operator sits. He's so high up that he looks quite tiny from below. He touches a lever, and the giant crane starts moving alongside the house. He presses a button and the crane's arm swings towards the house, hoisting up a case of bricks. As soon as the case reaches the top floor, the workers unload it.

In the old days people had to carry the bricks themselves. We used to call the brick-carriers in Russia "goat-carriers," because they carried the bricks in a "goat." Not a live one, of course, but a wooden one. The bricks were stacked in a barrow with two curved handles. These handles resembled goat's horns and that's why the barrow was called a "goat." The "goat" was set on a stand the height of a table, so that the carrier would not have to pick the load up from the ground. It would have been still harder to do that. Having stacked about 30 bricks in the "goat," the carrier would hoist it on to his back in such a way that the horn-like handles hooked over his shoulders. A man had to be very strong and agile, otherwise, when he hoisted the "goat" on to his back, he would collapse under its weight. The load had to be carried over shaky boards to the fourth and fifth floors.

That's how things used to be. But when they were building the houses in our street, there wasn't even a shadow of a "goat-carrier" to be seen. Why should people break their backs when machines can be made to carry the bricks for them?

The bricklayers worked hard, especially a young lad. One morning he came to work and saw a banner hanging under the top row of bricks he had laid the night before. The big letters on the banner read:

Greetings to the Best Bricklayer!

He was really amazed. After a minute he said to his helper, "Let's get started! We'll be a shame if they take the banner all away." So they worked still harder, and the wall grew faster and faster. At the end of the day the young worker looked at the wall and saw that the banner was now far below the top row.

When he came to work the next morning the banner had been moved to the top row of bricks again. And as it went down that day as all day long he tried to get as far away from the banner as possible, but by morning it was always waiting for him on the top row. And that's how they received the word together. By then the young worker had become the most famous bricklayer in the whole world.

A bricklayer's work is not easy. It's not quite so easy to put a big house together from little bricks, and it can't be done without knowledge and skill. The bricks have to be laid accurately, or pressure the walls from crooking.

A cabinetmaker uses glue to join various parts of his work together. A smith uses thread. A carpenter uses nails. But a bricklayer uses mortar. Mortar is a paste made from cement or lime and sand. When each brick is put into the space between two bricks, the longer it stays there the harder it gets, and it joins the bricks together so well that it's impossible to pull them apart again.

The bricklayer skips the mortar on the lower row of bricks with a small shovel called a trowel. Then he lays the upper row of bricks on the mortar. He takes care that the bricks do not lie exactly over above the other, that the end of each of the top bricks comes over the middle of one of the bottom bricks.

If a wall is well built it will stand for hundreds of years. Some ancient buildings have even been standing for a thousand years.

While the bricklayers were putting up the walls, other workers were building partitions, laying beams, covering them with floors, finishing the ceilings, putting in the plumbing, connecting the telephones, wiring the houses, and installing the radiators. Finally, the house was built right up to the roof. Then the roofers took over. All the workers moved on again to the next stage. The labourers started digging pits for the fourth house, the concrete-layers began pouring the foundation for the third one, the bricklayers began putting up the walls of the second one, and the roofers began roofing the first one.

The plasterers and painters came after the roofers. After them came the ones who were last in line—the people for whom the house had been built. Who were they? They were working people too, like the people who had built the house—bricklayers and steel-makers, teachers and doctors, fitters and printers, scientists and engineers.

The new tenants drove up in lorries with their tables and chairs, chests and wardrobes, beds and couches, cups and saucers, books and toys. One brought a cat, another a dog, a third a bird in a cage. And then a goldfinch started singing on the top floor of the first house, and a cat sat sunning itself on the ground-floor window-sill. They were still wiring the second house. In the third they were plastering the ceilings. They were roofing the fourth. In the fifth they were putting up the walls. In the sixth they were laying the foundation. In the seventh they were digging the foundation pits. And they were still planning where to lay the foundation for the eighth house.

Now there are twelve houses standing in two rows in our street. The first house is the oldest, it was started first and finished first. The twelfth one is the youngest, and the tenants are just beginning to move in.

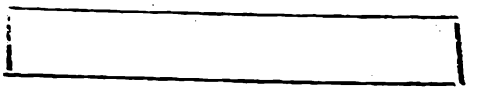
Flowers bloom in the yards, children play volley-ball; there's a lift in each house, and shiny cars are parked along the street. It's hard to

believe that not so very long ago all these houses existed only on paper, on the huge sheets of heavy paper where the architect had drawn up the plans of the houses, of their exteriors and their inside structure.

Now you'll see why the numbers of the houses in our street are so strange. Three little houses numbered 1, 3, and 5 were replaced by one big house numbered 1-5. Six little houses numbered 7, 9, 11, 13, 15, and 17 vanished and made room for a huge house a block long, numbered 7-17.

One day a boy and a middle-aged man came down our street. They stopped near No. 1-5, and the man said, "You see this big house? It's mine." They walked on and stopped at the next house, No. 7-17. The man said, "You see this big house? It's mine." They walked on and stopped at the next house and the man said again, "This one is mine too. And the one across the street near the cinema is also mine. I guess all the houses in this street are mine."

The boy was amazed. "You're joking," he said. "No one can live in so many houses at a time!" But the man laughed and said, "I only live in one of them, but I plastered all of them. That's why I feel happy every time I pass by, for these are all my houses!"



You can write the title of this story into the empty square above after you have answered seven questions and solved seven riddles.

The answers must be brief, for there's not much space in the square. And you must give the same reply to all the seven questions. Here they are:

Where does it never rain or snow?
Where is it warm in winter and cool in summer?
Where is the night as bright as day?
Where does a river flow over people's heads?
Where are there only passing visitors and no permanent residents?
Where do clocks without hands tell the time?
Where do the steps move by themselves and the doors open by themselves?

You probably know the answer already. There's one answer for all these seven questions and that is: in the Metro. The Metro is Moscow's underground railway. So now you know what the title of this story should be.

Everyone who goes to Moscow sees the Metro. And even if you haven't been there yourself, you have heard about this underground city beneath Moscow which has its own streets and marble palaces. Fast electric trains race along the underground streets, the tunnels leading from one palace to another. Everything is different in the underground kingdom. Above ground day slips into night, but below it is always light, and you can never tell whether it's morning or evening.

Where does this underground light come from? It's hard to tell at first glance. In one palace the light streams down from the ceiling. It's as bright as day, but there are no lamps to be seen, for they are very well hidden. In another palace the light seems to spring up from marble bowls, just like water in a fountain. In a third there are tall rows of crystal lamps. In a fourth a chain of lamps wreathes the domed ceilings.

Electric current runs along countless wires to the lamps, chasing away the underground darkness. In this city beneath the ground it never rains or snows, it's never hot or cold.

There's a snow-storm outside. People hurry along with their collars up and their hats pulled down over their ears. It's calm and quiet in the

Metro. If you hadn't just gotten chilled to the bone outside, you'd never have said it was winter.

In the summertime it's the other way round. It's hot and humid outside, but it's cool in the Metro. Here, the weather obeys man. The air in the Metro is fresh and clean. There are machines called ventilators which help to air the underground city.

There are big stone boxes in the parks and squares of Moscow. Each one has large, screened windows on two sides. The screens are so fine that you can't see a thing through them or find out where the humming noise inside the box is coming from.

This box is Metro's mouth and nose. It breathes in fresh air through the screened windows, and that is why the stone boxes are built out in the open, near trees and grass. The air passes through the stone box and into a deep well, where it reaches a powerful machine called a ventilator, and this is where the humming noise comes from. The ventilator sucks in air and sends it on to the underground station, where other ventilators expell the stale air up above ground.

But why is the Metro cool in summer and warm in winter? In winter, when it is cold outside, the air is sucked in between the stations and sent on towards the nearest station by a roundabout route, through the corridor-like tunnels, to give it time to warm up. In summer the fresh air is let in at the stations and sent out in between them after it has warmed up.

The trains help to ventilate the underground city too. When they race along the tunnels they push the stale, stagnant air in front of them. It has nowhere to go and is forced upwards through specially built air shafts. That's why it's never stuffy in the Metro, even though it's always crowded.

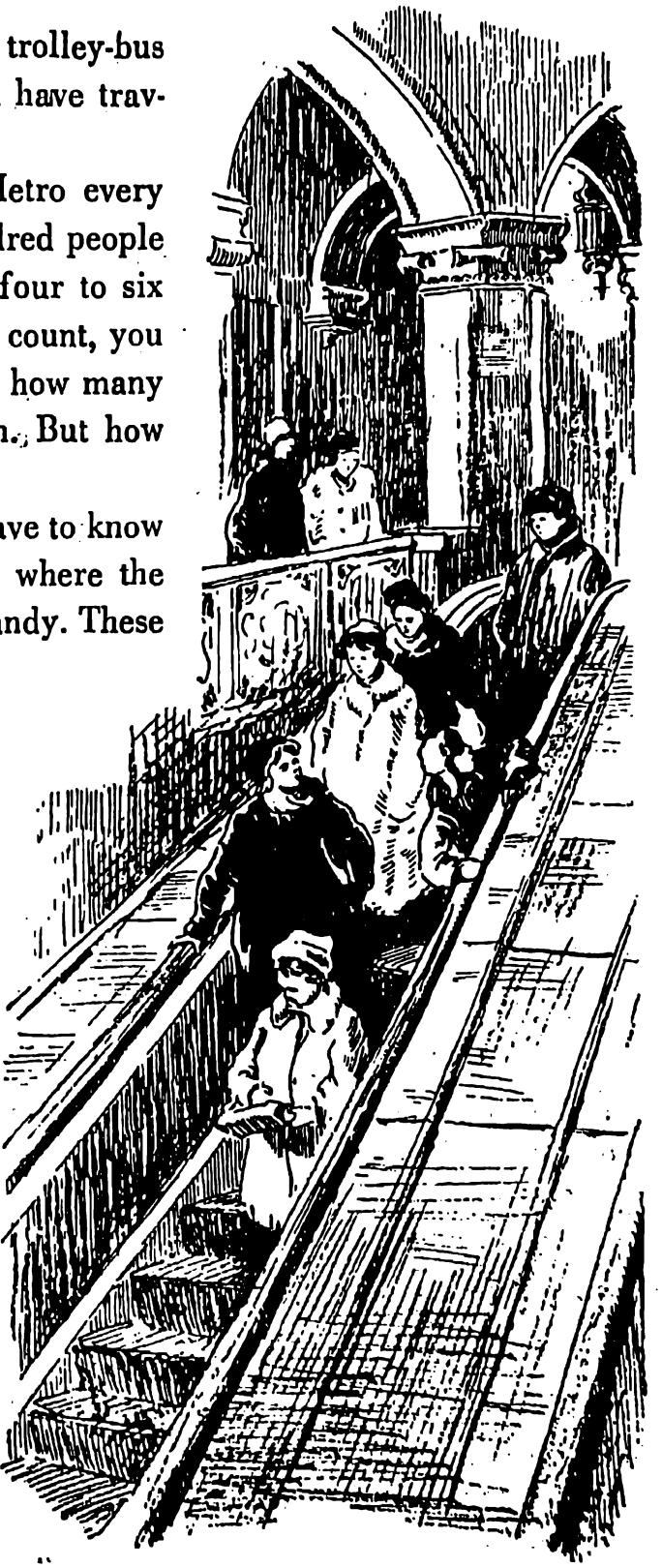
Trains travel quickly underground. Nothing stops them from going at full speed, nothing blocks their way. On the surface people travel in buses, trams, and trolley-buses. By the time a tram covers a distance

of three miles, and a bus and trolley-bus four miles, the Metro train will have travelled ten miles.

How many people use the Metro every day? There's room for two hundred people in each carriage and there are four to six carriages to a train. If you can count, you won't find it difficult to discover how many people there are in a full train. But how many trains are there?

In order to count them, you have to know how often they pass by. Here's where the clocks in each station come in handy. These clocks are special ones, they have no hands, but they tell the time accurately. As soon as a train has left the station, the huge clock on the wall starts ticking off the seconds, so that people can tell when the last train left and when the next one is due.

Every five seconds numbers light up on the dial, one after the other, as if they were running round in a circle: 5, 10, 15, 20, and so on till 60. As soon as the number 60 lights up, a large "1" appears in the centre of the clock. That means that one minute has gone by since the departure of the last train. In



another sixty seconds the number "2" will light up. But before this happens the next train has pulled into the station, picked up the passengers and started on its way. And the clock has to begin its count all over again.

There are twelvé hundred passengers in each train, and the trains pull into the stations at the rate of one every two minutes, or even more frequently. So you can begin to count how many people use the Metro in a day. It's not an easy sum to do. In two days all the residents of Moscow could travel in the Metro if each one rode just once from one end of the line to the other. In two months' time every person throughout the whole country could travel in the Metro. And in two years everyone in the whole world could make one trip in it.

The trains speed on underground: a train every two minutes.

But why don't they collide? Why don't the trains behind smash into the trains in front of them? There's a motorman in each train whose hand never leaves the button that starts and stops the motor. The motorman looks through his window, and if he sees a red signal ahead he immediately stops the motor, bringing the train to a halt. Who turned on the red signal? A person? No, not a person. It was the train ahead that did it.

A train is made so cleverly that it knows how to turn on the red and green lights of the signal. A red light means the track is occupied. A green one means the track is clear. But what if the motorman slips up on the job and speeds past the red signal?

This should never happen.

The Metro motormen are experienced and reliable people. They know that they are responsible for many lives. But a motorman might get ill suddenly and miss the signal through no fault of his own. What would happen to the train then? A very wonderful machine called an automatic trip has been invented for just such emergencies. It's an electric watchman and it's always on the alert. If the first carriage of a train

should pass the red signal, the automatic trip will immediately slow down the train and bring it to a halt as if it were saying, "Stop, don't move!"

Everything in the Metro is worked out to ensure the passengers' safety. When you ride in a train you don't even know that the station-master is watching the train's progress. He's the one who directs all the trains. You're still quite far from the station, but he can see your train and watch it race along the underground tunnel. Can a person see through the ground? Apparently he can. That's why the dispatcher, the person in charge of all the trains, sits at the terminal station before a luminous wall map. All the different tracks, crossings, signal lights and switches are represented by many coloured lines and symbols, so that he can see where the trains are at a glance. Each train sends along a message saying, "I'm coming!"

The dispatcher can control a switch on the tracks from his office and send a train along another track. He controls the traffic from afar, as if his arms were miles long. He is helped by electricity. The electric current runs along the wires to the station, where it lights up the map in the dispatcher's office. The same electric current relays the dispatcher's order to the switches, sending a train from one track to another.

It's hard to tell about all the wonders of the Metro in a few minutes. The carriages join up into trains by themselves. The doors open and close by themselves. The stairs there carry people up and down by themselves. These moving staircases aren't solid, but are made up of separate treads like links in a chain. Each tread rolls along a track on rollers like a little waggon. The treads are all attached to a chain and are pulled upwards by it. When the treads reach the top they disappear under the floor and go back down for new passengers. The handrails move above the stairs, always keeping up with them. But it's only an illusion that everything here gets done by itself, without the help of people, for even automatic machinery has to be controlled.

There are many wonderful machines in operation in the Metro, and many other wonderful machines worked to build the Metro. Instead of being amazed by the machines, we should think of the people who made them, who built the city below the ground. Do you think it was easy to build palaces and tunnels under the ground? And not just under some empty lots and wasteland, but under huge houses, under the very streets of Moscow.

They had to tunnel out mountains of sand, clay, and stone from beneath the city, taking care not to spoil the pavements, not to damage the water or gas mains, not to break the electric and telephone cables. In some places the tracks had to be laid beneath the bed of the Moskva River. That's how a river came to flow over people's heads.

But the builders had the hardest time with the underground rivers, and not with those that flowed on the surface. The underground rivers washed away the sand and clay. Then the waterlogged sand would become fluid and start to move, making the ground cave in when work was in progress. In many places they had to pump the water out before they could get on with the work. They even started using air to fight the water. Air was pumped in through pipes, and it forced the water back, giving the sand a chance to dry out. It was easier to take the dry sand out of the tunnels under construction.

Then they used cold to fight the water. A very cold liquid was pumped into the wet sand to freeze it and harden it. It was easier to work with the hard sand, because it didn't slip and hold up the work.

See how brave and clever were the engineers and workers who built a wonderful underground city called "Metro" beneath the streets of Moscow!

In the very end, at least, we should say something about the word "Metro" and its origin.

In our everyday speech we often simplify long words and make them shorter. Such was the fate of the word "metro." Its full name is really "metropolitan." This long word comes from another long word "metropolis." "Metropolis" means main city, capital.

The Metro is the main city's railway.

THE CARS IN OUR STREET

How many cars there are in the street! They speed along, one after the other, and there's no end to them. Here's a *Pobeda*, and there's a little *Moskvich*. It only seats four, but a gallon of gas goes a long way in this car. What's that big car that left all the others behind? It's a large, seven-seat *ZIS-110*. The cars speed on, but they have to slow down and stop when the traffic light at the crossing says, "Stop!"

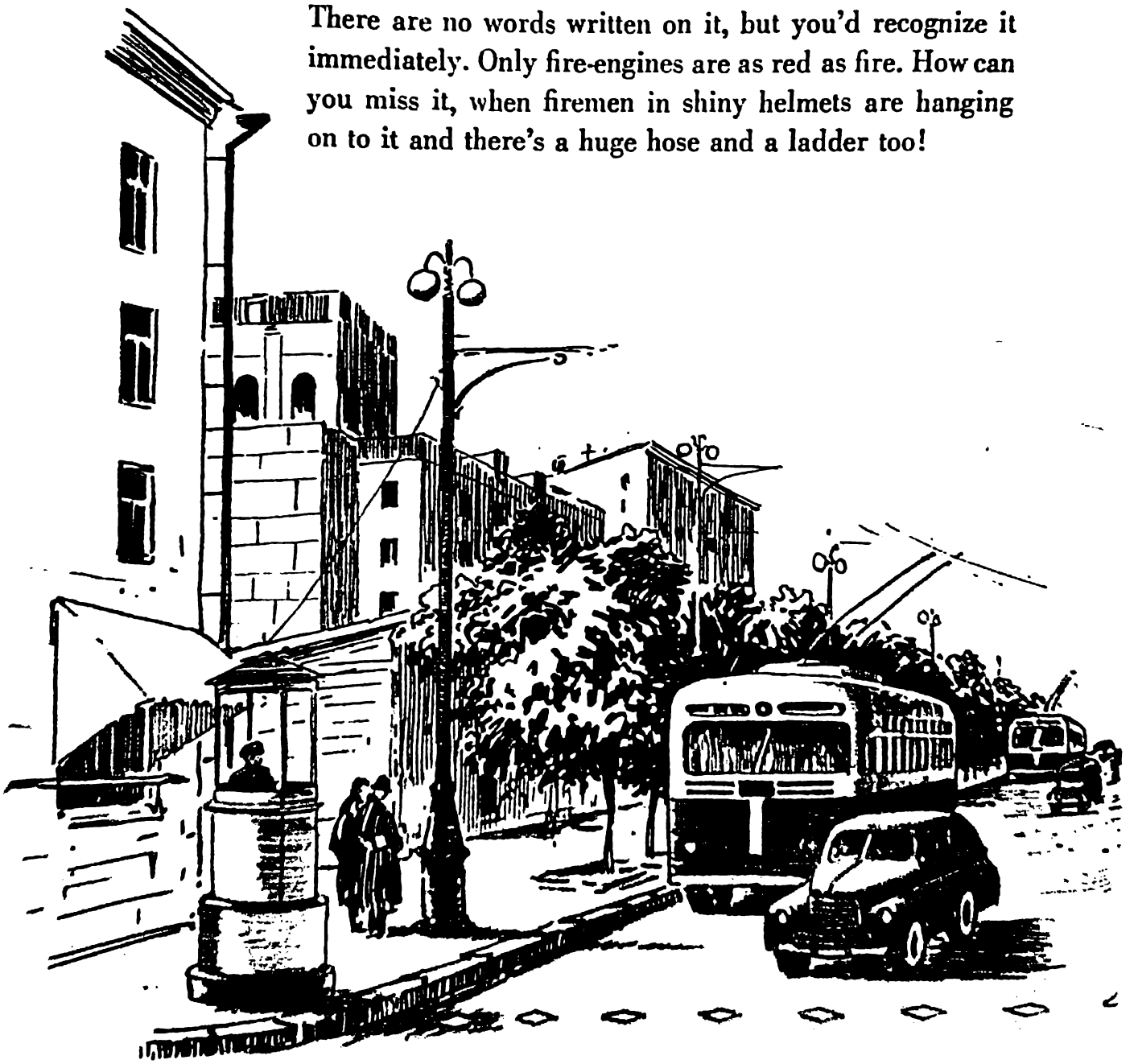
The traffic light can't talk, it uses signals. There are three lights, one above the other: a red one, a yellow one, and a green one.

The red light means: "Stop! The road is closed!" The green light means: "Go! The road is clear!" And the yellow light means: "Don't rush! I'll tell you whether the road is clear or closed."

How does the traffic light know what to say? Can it see whether the way ahead is clear or not with its three eyes? No, of course it can't see. The militiaman who sits in the glass booth on the corner sees for it. He controls the traffic signal, turning on the right light. He lets the cars pass in turn: first those from our street and then those from the side street. If there were no militiaman or traffic signal, the cars would all collide.

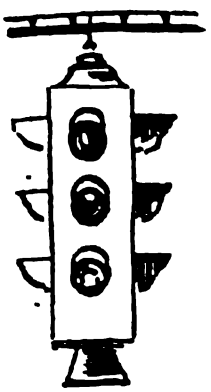
There are certain cars which the militiaman lets through out of turn. These cars speed down the streets with sirens screaming and never stop at the lights. One of these has the word "Ambulance" written on it. You can see a stretcher through the window and a sick person lying on it. There's a doctor in a white coat sitting next to the patient. Why does everyone let the ambulance pass? Because a sick person has to be taken to a hospital as quickly as possible.

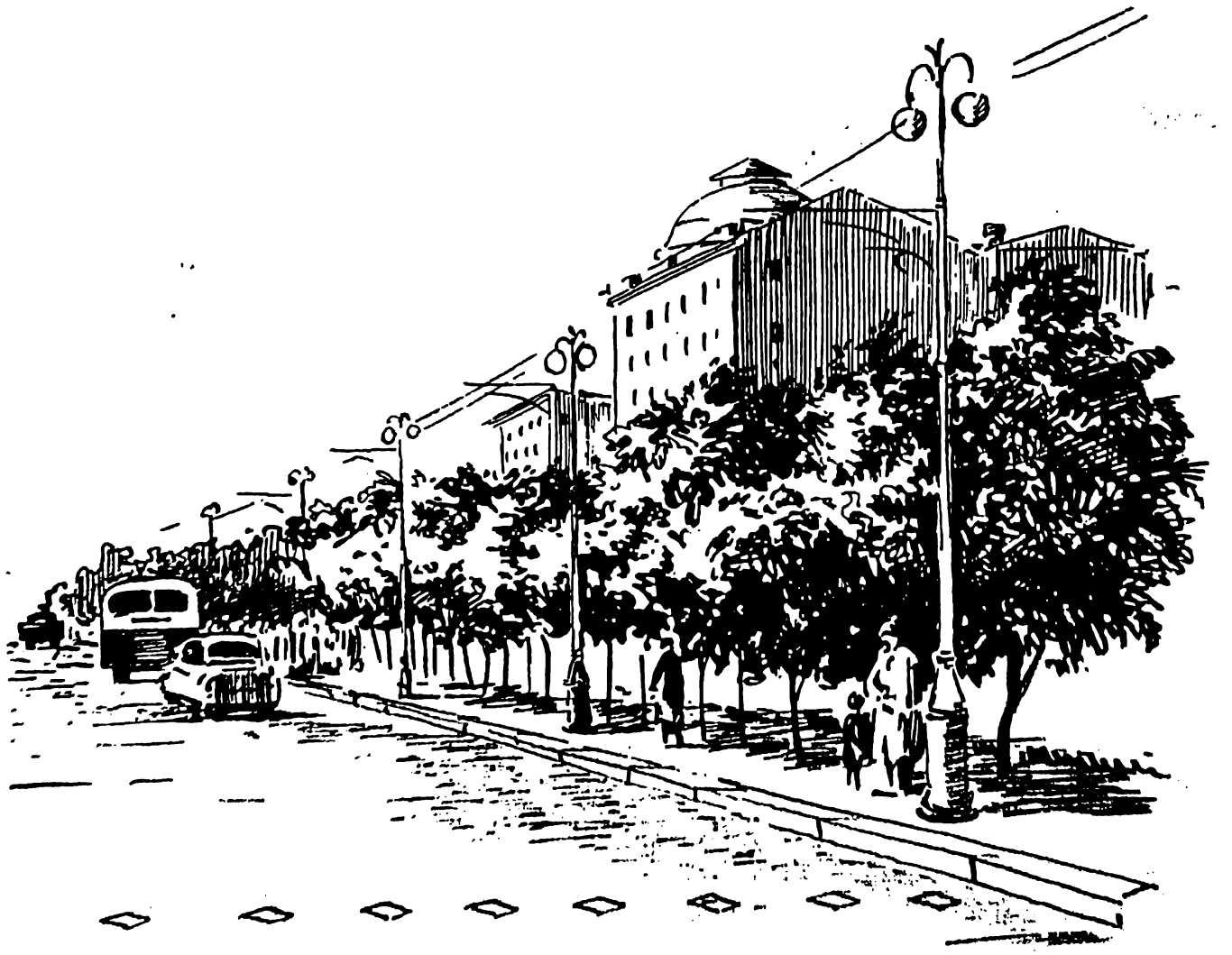
And here's a car which all the other cars let through. There are no words written on it, but you'd recognize it immediately. Only fire-engines are as red as fire. How can you miss it, when firemen in shiny helmets are hanging on to it and there's a huge hose and a ladder too!



A fire-engine always has the right of way, for a fire has to be put out before the house burns down! That's why it travels with such speed. And that's why, when someone is in a big hurry, you say, "Where's the fire?"

Many cars pass our street and each one is going somewhere. Here is a lorry with "Bread" written on the side. There are shelves in it just like in a cupboard, and there are wooden trays stacked with fresh, warm loaves on the shelves. Here's another lorry. The word "Fish" is written on it. It is loaded with fish. And here's a dust cart. It helps keep the streets and yards clean. People throw their butts and papers in dust-bins or waste-paper baskets. When the dust cart drives up, the rubbish is dumped into its large scoop. When the scoop is full it turns the rubbish into the cart.





There is also another kind of ambulance. This one is for sick cars, not sick people. Sometimes a tram or a trolley-bus stalls in the middle of a street. Why has it stalled? Because something has gone wrong with the overhead cable. It has to be fixed, but how in the world can anyone reach so high?

This is where the "Technical First Aid" lorry comes to the rescue. This lorry has a thick pole on it with a kind of crow's nest at the top of the pole. A man is standing on the platform of the crow's nest. He's a technician and knows all about fixing cables. Suddenly the pole starts growing, raising the platform and the man on it. Before you know it, the technician has reached the cable and has started working on it.

Then there are carts which clear away the snow. There was a great deal of snow in the streets of Moscow last year. The janitors started to shovel it away early in the morning, but it kept on snowing and snowing. The snow interfered with traffic and made it hard for pedestrians to cross the streets. So they decided to call a wonderful shovel to their aid. Have you ever seen this wonderful shovel at work? It moves along the street, scooping up the snow and throwing it into the cart. All summer long the snow-plough is on vacation. Its place is taken by a water cart which sprinkles and washes the streets. The huge cart moves along the street, with a fountain of water spouting out from each side.

We really have a lovely street. Tall lindens line the pavements. They are so big that they look as if they have been growing there forever. But the people in our street know that they are new-comers.

In olden times trees never dreamed of changing their surroundings. Nowadays big lorries take them to be transplanted where they are needed. They even do this in the summertime, in June or July, when the tree is in full bloom. It's uprooted carefully together with the earth surrounding it. The trees are transported in huge wooden crates, just like flowers

in flower-pots, so as not to damage the roots or loosen the earth around them. But a flower is small and a linden is huge and heavy. How can it be lifted and then lowered into a pit?

This is where a crane mounted on a lorry goes to work. It lifts the tree off the lorry and lowers its roots into the trench. A whole crowd gathers to watch the operator of the mobile crane who goes about his work carefully, trying not to bump into anything.

Now the tree has a new home in a busy street, yet only this morning it was growing in a quiet grove, miles away from the city.

Not long ago they were laying pipes in trenches along our street. They were laying them in order to bottle up a little stream which used to flow on the surface before. Now it has been trapped in great underground pipes, like dungeons, and it's not in people's way any more.

The pipes are so big that you could walk around inside without even bending your head. They were laid by the mobile crane that had helped transplant the trees. It would lift an enormous pipe and then lower it into place, that's how skilful and strong it was.

And now, look under your feet. The road was paved by machines, too. This very minute they are covering a road with asphalt, and an asphalt-laying combine is moving along the street. It lays the hot black asphalt in an even layer over the road, pounds it down to make it solid, and then smooths it out with a steam-roller.

A tip-up lorry which dumps its load wherever necessary keeps driving up to the asphalt-laying combine. It transfers its load of hot asphalt to it, and goes back for another load. And now the hot asphalt lies steaming on the roadbed. It cools quickly and becomes hard, but before it hardens it must be pounded down and flattened out for there must not be a single bump on the surface of the road. The cars must be able to roll along it easily and the road ahead of them should be smooth.

In order to be smooth it has to be ironed, and a special road iron has been invented. It's a huge steel roller, but you'd never be able to roll

it by yourself. Only a powerful motor can move it. You've surely seen a clumsy-looking steam-roller at work before. It goes back and forth over the hot asphalt and irons it.

Let's take another look at our street. It would be hard to build a street like this without machines. Machines helped the workers to build the houses, machines planted the trees, machines paved the street, and machines in the shape of cars and lorries now ride along the asphalt.

HOW THE RIVER CAME TO VISIT YOU

You turn on a tap and hold a cup under it. Something gurgles behind the tap and then a stream of clear cold water runs out into the cup.

Where did the water come from? From the river. But it's a very long way from your house to the river. How did the water reach the tap? And how did it get as high as the fifth floor? This is a story about the water's journey.

Everyone knows how water comes *out* of a pipe: you open a tap and the water flows out. But how does it get *into* the pipe?

On a river-bank, far from the city, there is a strange tower, whose windows are below water-level. Day and night water pours in through the gratings of the windows. Fish swim by and peer into the tower, but they can't get inside, for the grating keeps them out. There are fine screens behind the gratings, and even the tiniest baby fishes can't squeeze through them.

Of course, it would be rather nice if you got a fish every time you turned on the kitchen tap. All you'd have to do then would be to hold

a saucepan under the tap to have fish chowder for dinner. But all thi is just wishful thinking, as the fish could never reach the tap anyway They'd only clog up the pipes.

Reeds, twigs, and leaves float down the river, but the gratings and screens in the tower keep the unwanted visitors out.

It is quiet and desolate all around. Now and then a river patrolman may pass along the river-bank or ride by on horseback. He keeps order on the river, and the rules there are very strict. It's against the law to swim there or go boating. No one is allowed to wash clothes, or let their cows out to pasture, or even walk along the banks.

Why are the rules so strict there? To protect the river. But does the river have to be protected? Can anyone steal it? Of course, not. It has to be protected from people who might throw things into it and make it dirty. If dirt gets into the river it can get to your tap. And if you drink dirty water you'll get ill.

People aren't the only ones to make the water muddy. The river churns its water up itself. It washes away the banks and carries off pieces of dirt, clay, and sand; it is especially muddy in the spring, when little rivulets pour into it from all directions, carrying everything they have picked up on the way. At times, during the spring floods or after heavy thunder-showers, the water becomes as brown as coffee or as white as milk. Unfortunately, such coffee and milk are not much use to us.

Water doesn't have to be absolutely pure to be used in factory machinery, but water for drinking or washing clothes must be purified. Powerful pumps send the water from the tower through pipes to the purifying station. Here the water has to slow down its pace and pause on its way from the river to the tap.

When a river flows along quickly its current is strong enough to carry off lumps of earth, sand, and clay. Mountain streams can even dislodge large rocks and carry them down the mountain slopes into the river.

The river will only give up all these treasures when it is made to flow very slowly. At the purifying station the water slowly passes through a great tank, as big as a two-storey house, and all the things it carried along with it settle on the bottom. To speed up the process, something is added to the water that instantly turns into large white flakes that make the dirt sink quickly. When you look at the tank it seems as if it were snowing in the water. The flakes fall to the bottom and carry the dirt with them. The water is slightly cloudy when it leaves the tank and might even seem to be clean, but this is one time when there's no place for guesswork. If we look through a microscope we'll see that each drop of water has its own inhabitants. The tiniest ones look like commas and dashes and are called bacteria.

The gratings and screens in the tower kept out the fish and reeds, but they couldn't hold back things that are invisible to the naked eye. These organisms must be kept out, for sometimes there are harmful bacteria among them that could make people very ill.

What can be done to prevent the bacteria from getting into the pipes? What kind of fence is needed to keep out the invisible enemy? It's easy to keep a fish out, all you need is a grating. Can we make a grating fine enough to prevent bacteria squeezing through, even though they are so small you cannot see them? Yes, such a grating can be made, but not from iron bars. It can be made from gravel and sand.

The water which has settled in the tank is pumped into a large light hall where the floor is laid with white tiles. Down the centre of the hall runs a kind of passage-way; to each side of it are reservoirs that look like small square ponds. The bottom of the ponds is covered with slits through which the water can run out. Then there is a layer of gravel and, on top of this, a thick layer of sand. The water seeps right through the sand, but the dirt and bacteria remain in the sand. Bacteria are many times smaller than a grain of sand, and the space between two grains of sand might just as well be a wide open gate, as far as they are concerned. What is it, then, that keeps them inside the gate?

This is what happens. When the river water seeps through it covers each grain of sand with a thin film of bacteria and tiny water plants. Other bacteria stick to this live film on their way through the winding paths among the grains of sand. It might seem strange, but the bacteria themselves help to clear the water of bacteria.

It is quiet and empty in the hall where the water is being filtered. The ponds look quite still and it doesn't seem as though any work were being done at all. A man in clean overalls and felt slippers walks up and down the passage-way. He has left his shoes at the door so as not to bring any dirt in from the street. One would think he was just admiring the water in the ponds, but actually he is checking to see whether

everything is in order. If the water seeps through too slowly, it means the sand has become dirty. Then the man goes over to a panel on which there are very many buttons. He presses one, and immediately some pipes are closed and others are opened. The water no longer flows into the contaminated pond, but is sent into a clean one.

When the water leaves this hall, it certainly seems clean, but some bacteria have managed to get through. In one of the rooms of the purifying station there are tables with microscopes and many other instruments on them. Laboratory technicians in white overalls check the water to make sure it hasn't secretly carried in any of man's invisible enemies. If one of the technicians sees such an enemy under his microscope he immediately informs the person in charge of the laboratory.

The river patrolmen are told to find out who has contaminated the water, and where. Perhaps someone washed a sick person's clothing a few miles up the river, and the water carried along the infectious bacteria.

In order to kill the hidden enemy, a yellow poison called chlorine is added to the water. Only a tiny amount is added, so as not to be harmful. When people drink the water they won't smell the chlorine, but even a small amount like this is enough to kill the bacteria.

The water has finally passed through the purifying station and is clean enough to drink. Now how will it reach the people in the city who need it? It's a long way to the city and the buildings there are tall. How can the water be made to go so far and so high?

When water runs freely, it moves downward, driven by its own weight. You know how much easier it is to run downhill than to climb uphill. That's why water flows from a brook to a stream, from a stream to a river, lower and lower until it reaches the lowest point, which is the sea. But the water in the pipes has to flow upwards, not downwards; towards the city, not to the sea. It has to go where it is told, and must not take the easiest way. It must even climb up to the tenth floor, if necessary.

Water must be forced to flow upwards, for it will never do that by

itself. That's why the water from the purifying station is sent on to the next station, which is called a pumping station.

There huge pumps send the water through large underground pipes that stretch for many miles. The water reaches the city through these pipes, as though it were flowing along an underground river-bed. When it gets to the city it branches out into other, smaller pipes. A stream will always flow into a river eventually. But here the process is just the opposite: a river is made to separate into many streams which flow away from it in all directions. These little streams, imprisoned in pipes, flow into the houses and up to the top floors.

When you open a tap the water gushes out. Why is it in such a hurry to escape? Because huge pumps at the pumping station are putting pressure on it and pushing it along. There must surely come a time when these pumps have to be repaired. What happens then? Are the houses left without water?

No, because water is kept in water towers for emergencies like this. You must have seen towers with round houses on top. Perhaps you've even wanted to climb the narrow stairway to see what was inside. There's a huge round tank filled with water inside. It's just like a pond that's perched high up over the houses and tree tops. The tower is built this high so that the water can then be forced down under great pressure and thus be able to rise to the top floors.

The river comes to your house from the country without its usual load of fish, water plants, garbage, and bacteria. The water comes to visit you, but it is not its usual self, it is clear and pure now. It doesn't flow according to its own whim, it has become obedient. It will trickle out or gush out in just the way you want it.

It wasn't easy to tame the water and bring it to you. It was guarded by foot and mounted river patrolmen. Doctors and laboratory technicians checked it. Engineers and plumbers built the long pipe road and the stations along the road.

Sometimes underground water is used instead of river or lake water, and in such cases wells are bored in the earth to reach it. Very often the water lies deep beneath thick layers of sand, clay, and gravel. Pipes are lowered into the holes, and if the water is very, very deep down, pumps are lowered into the wells in order to pump the water up.

All this is not easy work, and ability and knowledge are needed to carry it out. Now, whenever you take a drink of water or a bath, you will know what the pipes are for, and how many people had to work so that you could summon up the water from a river or from the depths of the earth by simply turning on a tap.

THE INVISIBLE WORKER

There's a worker whom no one has ever seen, but whom everyone knows. It can do anything, and with such speed, too!

In the morning you say, "Boil the water for tea!" and in five minutes the water in the kettle is at a rolling boil. Then you say, "Cook the porridge!" and before you know it, the porridge is cooking. You had better keep an eye on it or it will boil over. If the ironing has to be done, this worker can do that, too. At night, as soon as it gets dark, it lights up the lamp. When your visitors are still outside it shrills, "Hurry up and open the door!" You will never get bored if you have it with you. It can sing and tell stories; it understands you so well, and is so obedient! All you have to do is move your hand, it will guess your wish and hurry to fulfil it. At home it helps you in every way; and it's just as indispensable out in the street.

If you had to go to the other end of the city it would take you a whole day to walk there, and you'd be very tired by the time you arrived. It can get you there in fifteen minutes. It has golden hands, although really it has no hands. It hoists bricks on construction sites, it forges iron and cuts steel in factories, it grinds flour in mills, and helps people stitch shoes in shoe factories. It's always at your beck and call and comes the minute you summon it. It's ready to work night or day.

Who is this nimble, obedient, and tireless worker? What is its name? Where does it come from? It is called "electric current" and now we are going to tell you where it comes from.

Look at an electric iron, an electric kettle, an electric hot-plate, or a table lamp. These are all unrelated objects, but they all have something in common. What is it?

Each one of them has a long tail, called a flex. This flex is the path along which the electric current runs. Look through your desk drawers and see if you can find a piece of flex. Then take its clothes off. It has a cloth coat and a rubber shirt underneath. Only when you have taken off its shirt will you see the cord itself, which is made up of a lot of thin copper wires twisted together. The current runs along these wires to the lamp or kettle.

The wires have a rubber shirt on to prevent the current from going astray. If you see an uncovered flex fixed to the live current, don't ever touch it, or it will run right into your hand from the wire. It will shoot through your body into the ground in a second, and will give you such a jolt that you will really be sorry you touched the wire. It bites hard, even though it's invisible. If the flex has its rubber shirt on, you need not be afraid of the current, for it can't get through the rubber.

How does the current get into the wires? It has to come a long way first. The flex on every electric kettle or iron is only a small lane. When you put a plug into a socket you connect this small lane with a big street.

The street is the wire that runs along the wall and disappears there. It leads to a porcelain fuse and then to a meter.

The meter is so called because it measures the amount of current used in the irons, lamps, and kettles. The fuse is a watchman. When everything is in order, the current can do no harm, but when there is a damaged cord somewhere, the current may burn up the cord and start a fire in the house. It is then that the watchman-fuse says to the current, "Stop! I won't let you pass!" How can it say such things?

Well, in order to get into your flat the current has to pass along a tiny wire in the fuse. As soon as the current overheats this little wire, it burns it out. Then the current has no place to go, for its road has disappeared. It's as if the fuse were saying, "You can heat the irons and kettles as much as you like, but I'll never let you burn up the wires. That's not why I let you into the house."

How does the current get into a house? It comes up from under the ground. Everyone knows about the cars, trams, and trolley-buses that run along the streets. But not everyone knows what goes on under the street, under our very feet.

Pure water from the river flows quietly in the underground darkness. When it reaches the houses, it climbs up to all the floors, so that people can bathe, cook, and wash clothes. Other pipes, for rain-water, are laid under the pavement near the water mains. Sometimes there's a cloud-burst over the city. It looks as though everything is going to be flooded and the streets will turn into rivers. But all the water disappears as soon as it stops raining, leaving the asphalt a shiny black after its shower-bath.

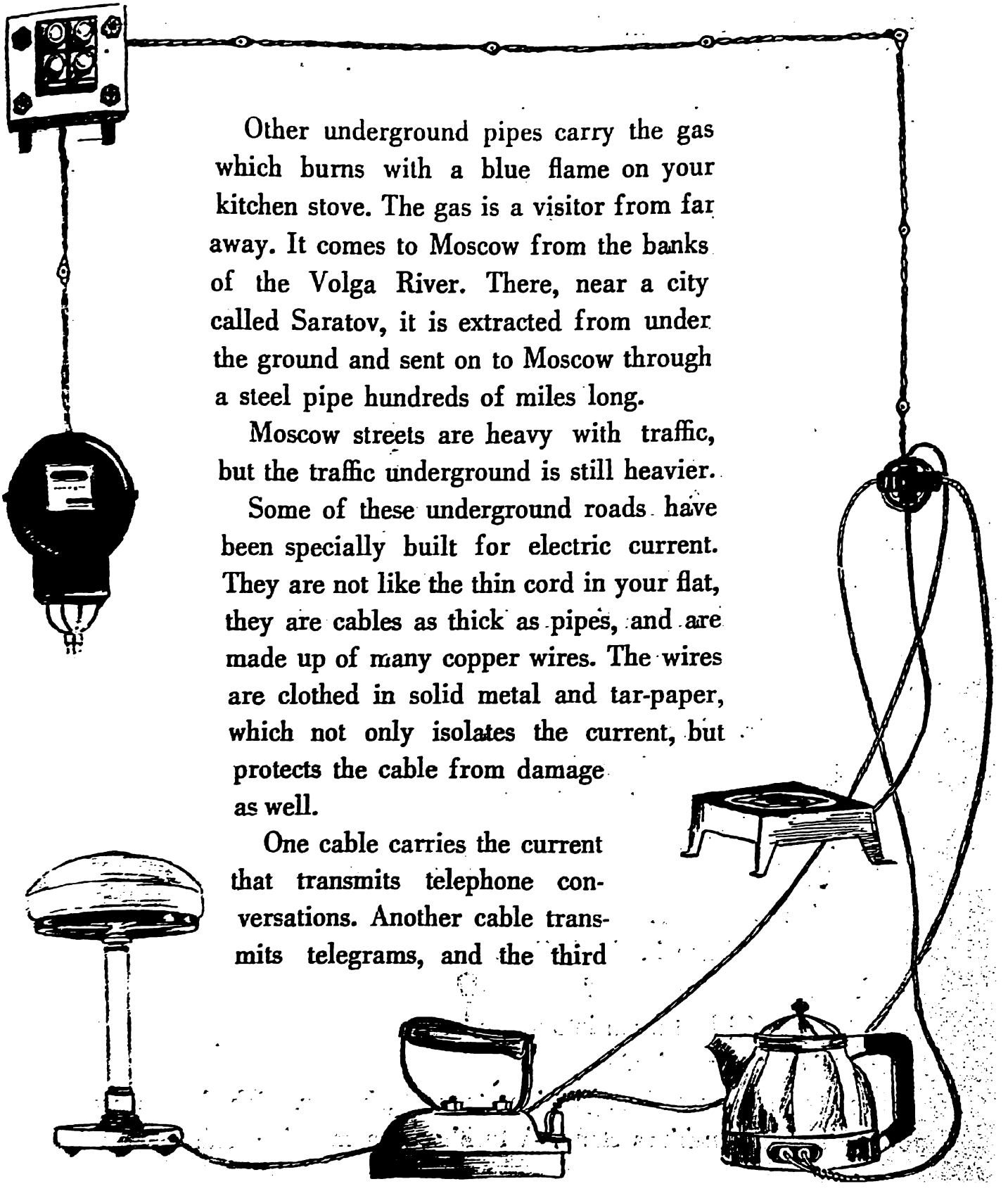
What happened to all the water? It flowed along the gutters to the drains in the street and there it gushed down through the gratings into the underground pipes. These pipes sent the water back to its rightful place in the river, for the city streets must always be kept dry.

Other underground pipes carry the gas which burns with a blue flame on your kitchen stove. The gas is a visitor from far away. It comes to Moscow from the banks of the Volga River. There, near a city called Saratov, it is extracted from under the ground and sent on to Moscow through a steel pipe hundreds of miles long.

Moscow streets are heavy with traffic, but the traffic underground is still heavier.

Some of these underground roads have been specially built for electric current. They are not like the thin cord in your flat, they are cables as thick as pipes, and are made up of many copper wires. The wires are clothed in solid metal and tar-paper, which not only isolates the current, but protects the cable from damage as well.

One cable carries the current that transmits telephone conversations. Another cable transmits telegrams, and the third



cable carries the current that lights up houses, heats irons and kettles, drives the trolley-buses, and runs factory machinery.

How does this working current get into an underground cable? It is born in an electric power station and from there it branches out in all directions along the underground and surface pathways to houses, factories, trams, and trolley-buses.

If you ever have a chance to visit a power house, you'll see first of all a hall with a high ceiling. It is so long that you could take a hundred steps and still not reach the other end. There's a row of furnaces there just like the fire-box in a stove, only much bigger. On the other side of the hall the wall is covered with all kinds of instruments made of glass and shiny metal. To the right and to the left under the glass panels, the hands of the instruments whirl round. Lower down on the wall is a long row of buttons and knobs which control the hands.

An operator stands near the wall facing the instrument panel. He watches the hands. From time to time he presses a button or turns one of the little knobs. He looks as though he were steering a machine, like a chauffeur in a car or a helmsman on a ship. What is he steering? Fire, water, and air. Fires blaze away in the fire-boxes; over the fire water boils in huge boilers. Air is blown upwards by a huge mechanical bellows and through pipes until it reaches the fire-boxes.

What is the air for?

To make the fires burn more fiercely in the fire-boxes.

What is the fire for?

To boil the water in the boilers.

Why must the water boil?

So that it will be turned into steam.

What is the steam for?

The steam is sent through pipes to another long, high hall where powerful steam turbines stand. A turbine is a machine with a wheel

inside. Steel blades are set in a circle all along the rim of the wheel. A large steam turbine has thousands of blades round its wheel.

The operator goes over to the wide pipe carrying the steam from the boiler to the turbine, and starts opening the valve very slowly. A valve is a lock which looks like a tap. If you open it you let the steam out through the pipes; if you close it, you cut the steam off. When the steam is turned on it shoots into the turbine with a loud hiss. But there, right in its path, stand the steel blades. The steam hits one blade, then another, and still another, making the turbine hum. This is the noise the wheel makes as it begins to turn. The steam keeps on pouring into the turbine, hitting the blades, turning the wheel faster and faster, making the turbine sing louder and louder.

You must have made a paper pin-wheel before. When you blow on its vanes it starts whirling round. But a paper pin-wheel is a toy. It is made for play, not for work. A steam turbine is a hard worker. There's a big machine called a generator next to it, which also has a wheel inside. However, its wheel is quite different from the turbine's. When the turbine wheel goes round it makes the generator wheel turn too, and when the wheel in the generator turns, it produces electric current. Wires carry the current into houses and factories, and to electric railways.

So, we have at last discovered where the current was born and found out where it gets the power to light up so many streets at once, to drive the trolley-buses and hoist up the bricks on construction sites.

If the coal had not burned inside the fire-boxes, there would not have been any steam. If there had not been any steam, the turbine wheel would not have turned. If the turbine wheel had not turned, the generator would not have worked. If the generator had not worked, the power house would not have produced any current.

There are also electric power stations and turbines which are driven by water instead of steam. The water pours in through a wide pipe

leading from a reservoir and turns the blades in the turbine. But we'll tell you all about this in another story.

Now, whenever you plug in your kettle or your lamp, you'll know where the invisible current comes from and what a journey it has to make from the electric power station to your room.

THE LETTER'S JOURNEY

Something clanged, and a new caller slipped in at the door. A faint ray of light shone into the house for an instant and illuminated the varied company assembled there. What a strange house it was! There were no windows. The door was on the roof, and the floor could be slid out from under the house. The visitors were a strange lot too. Many of them had white, blue, pink, and violet paper clothes on. We must add that the house was very small, more like a tiny cottage, really. Probably, you have already guessed that we're talking about a very ordinary street letter-box, and that the society gathered within its walls was made up of letters, not people.

There were letters wearing paper coats of every possible colour and adorned with pretty stamps. The stamps bore the pictures of scientists and writers, aviators and miners, ships and aeroplanes. One envelope had no stamp at all. Apparently this passenger was counting on someone paying his fare at the other end of the line.

The character of each letter could be guessed without even opening the envelope. A business letter was easy to spot by the typed address. The spelling was not always of the best in letters written by children. The postcards were ready to tell the whole world things they were

entrusted to tell just one person. That's the way they are—extremely outspoken by nature. But the envelopes kept their secrets well, and you could not tell by looking at them whether they were carrying good news or bad.

No two letters were alike, and even though they had all gathered together under one roof, they were only passing acquaintances, for they were destined to disperse in all directions. Some were about to journey across rivers and oceans, through forests and over mountains. Others had been sent out with their destination only on another street in the same city.

The door kept clanging and clanging and new visitors kept arriving in the little cottage. They were beginning to feel cramped, when suddenly the floor fell away from beneath them. The whole company fell into a bag the postman had put under the box. Only one bright picture postcard got stuck against the wall, and even then it wasn't forgotten. The mailman put his hand inside the cottage and felt around. He found the postcard right away, even though it was playing hide-and-seek with him.

This is where the letters' journey began. The mail-bag was put on a van and taken to the post office together with many more such bags.

When we drop a letter in a letter-box we never worry about how it will reach its destination. We know that all we have to do is to write a few words on the envelope, and the letter will not get lost; even if it has to journey far into the Siberian forests or into a tiny valley somewhere in the Caucasus. If the magic words which we call the address are correctly written, the letter will always go to the right place.

How does it find its way? The people who work at the post office help it to do that. They sort the letters and see where each one has to go. In the post office there is a large room with pigeon-holes along the walls that look like open boxes. Letters which are to be travelling companions are put into the same box—for instance, all the letters going to Leningrad and to the stations between Moscow and Leningrad. All the letters going in the same direction are tied together; a lot of such packets are put in

bags which are sealed, placed on a conveyer belt, and carried outside to a waiting van. Then the travelling companions are rushed to the railway station to catch the train. The whistle blows, the buffers clang, and the train steams out of the station.

Some of the passengers look out of the windows, others read or doze. But the people who ride in the mail-van have no time to look out or doze. They are busy sorting the letters and putting them in the proper boxes, so that none of them will miss their stations. All the letters which have to leave the train at the same stop are put into one bag.

The train stops at a small station deep in the woods. It only stops for a minute, but then it really doesn't take long to hand over a mail-bag to the postman who is waiting for it, or just to drop it on the platform. The letters are taken into the post office next door to the station. In an hour or so the rural postman is carrying them down the village street. The children run out to greet him, shouting: "There's our paper!" "Any letters for us?"

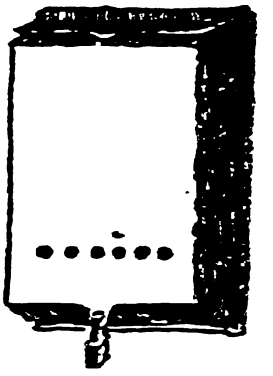
One boy is the envy of all his friends as he proudly carries home a big fat letter from Moscow, besides the daily paper. They all know that the letter is from his older brother who is a student. Two days go by and a still fatter letter from his whole family starts on its journey in the opposite direction.

From the village letter-box it goes to the village post office, from there to the mail-van of a train, from the train to a waiting mail-van which drives off to the Main Moscow Post Office. This is what's written on the envelope:

Nikolai Sergeyev
Flat 37, 40 Leningrad Highway,
Moscow 40

In a village everyone knows everyone else, but it's not so easy to find Nikolai Sergeyev in Moscow. There are so many streets, so many houses

in each street, so many floors in each house, and so many people on each floor.



If the postmen at the Main Post Office were given the letters right off the train, as they were at the village post office, they would wear themselves out completely. They would have to walk back and forth across the city all day long, and it's many, many miles from one end to the other.

So to make this job easier, the city is divided into districts with a post office in each district. If the address says "Moscow 40," that means that the letter has to be sent to the fortieth postal district, which includes Leningrad Highway.

Every day trains from all parts of the country arrive in Moscow bringing hundreds of thousands of letters. How can this mountain of mail be sorted quickly, so that each letter can be sent to the right person?

There's no time to waste, for the letter may be urgent. Just imagine that someone has written to say: "I'll be passing through Moscow on the 5th at 3 p.m. Meet me at the station." And you find out about it on the sixth, after the train has long since left the city.

Letters cannot wait around in the post office, they must be sorted and delivered to the postal districts at once.

Everywhere machines help man, and at the post office, too, there are machines which speed up and simplify the work. There's a machine that stamps the letters. It works so fast that it stamps thirty thousand letters an hour. But the most amazing machine is the one that sorts the letters according to the various postal districts. It's so big that it takes up most of the room. The sorters sit on one side of the machine and press buttons numbered the same as the pigeon-holes on the wall. The sorter picks up the letter marked "Moscow 40," drops it into the machine and

presses a button numbered "40." The letter goes through the machine and falls straight into the right box.

Then the binding machine goes to work. It ties all the letters going to the same postal district in one bundle. A few minutes later bundles of letters in mail-bags are on their way to Leningrad Highway. In the district post office the letters are sorted once more, this time according to sectors. Each postman has his own sector which he knows as well as his own back yard; he can even find his way in the dark.

Finally, the letter from the village has reached its destination: the letter-box on the door of the flat where a student named Sergeyev lives.

We are so used to the post that we take it for granted. We know that a letter will always reach the person it is meant for. If he lives far from a railway, the letter will be sent from the nearest station by mail-van. If it has to cross a big lake or sea, it will continue on its way by boat. There are places where no train, no boat, no van can ever go. Then the letter will be flown by air. Even the people who live on the tiniest northern island receive news from home and send news home.

The post, the telephone, and the telegraph have linked up all the regions, cities, and villages of our vast country. It's hard to believe that there was once a time when it was very difficult for people to correspond. We read about such times in books. Before the October Revolution there were no village postmen in Russia. Even in a small town a letter-box was an oddity, let alone in a village. If someone living in a village wanted to post a letter, he had to go to the post office in the nearest town. In places where there were no railways or boats, the mail was not delivered by van or aeroplane, it came on horseback, by camel, on

dog-sleds, and by reindeer. If a person went to the Far North or into the desert for a long period of time, his family had no way of knowing whether he was dead or alive.

If we look further back into the past, we find that not so very, very long ago a city post office was a novelty even in a capital city. There wasn't a single letter-box in Moscow a hundred years ago. Whenever a person had to post a letter he took it to the grocer's shop. A sign on the front door read: "We accept letters for the city post office." The grocer charged 20 kopeks to send the letter on to the post office. Postmen would make the rounds of all the grocer's shops and collect the mail three times a day. These postmen all looked very impressive: they wore very tall patent-leather hats decorated with copper double-headed eagles and had dirks hanging from their belts. If a postman had to carry the mail to another city he took his sword with him. A postman's job could not have been very safe if he had to be armed to carry out his duties. Mail was sent out of town in a coach drawn by three horses. The roads were so bad that the poor postman who was perched on top of the mail-boxes was rattled and jarred at every bump. The journey was specially unpleasant in bad weather or during spring thaws. And it was not good for the letters either, since they were often lost or delivered weeks after they had been posted. People got the latest news long after it had ceased to be news.

We should remember these times in order to really appreciate our modern postal system and the fast, efficient work of many thousands of postal workers, who bring the farthest cities and villages right up to our doors.

GUESTS FROM FAR AWAY

Just before New Year's a fir-tree was put in the middle of the big hall of a factory club. The tree reached right up to the ceiling. Where could they ever have found such a tall tree? They found it in the forest, where it grew peacefully, never dreaming that it would soon have multi-coloured lights and red glass balls shining among its thick green needles, that threads of silver and gold tinsel would cover it from top to bottom, or that lovely toys would hang from all its branches. The fir-tree had never imagined that a red-checked Grandfather Frost with a long white beard would come to stand by its trunk, where once only rabbits had played and little white mushrooms had grown. How could it know that on its very top branch, which soared upwards like a steeple, a large, shining, five-pointed star would blaze forth.

You and your friends had fun skipping around the tree in a circle, playing games, singing and dancing. How you hated to go home when the New Year's party was over! But at least you didn't go home empty-handed. All the children were given little red cellophane bags to take home.

There were a lot of interesting things in each bag. There was a big red apple which had come from very far away. In the summer it had been hiding among the leaves of a great apple-tree, growing in an orchard at the foot of tall, snow-capped mountains. If the tree had been smaller it would never have been able to bear up under the weight of its huge apples. There are so many apples in those parts that a city has even been named after them, for in the Kazakh language "Alma-Ata" means "father of apples." And Alma-Ata is the capital city of Kazakhstan.

It's a long way from Alma-Ata to Moscow, and the apples had to start out on their journey over a week before in order to arrive in time for

New Year's. They were transported by rail across deserts and plains, through forests and over mountains. Whenever the train stopped at a station, the people there would say, "What a wonderful smell! There must be apples in these waggons."

There was a tangerine in the little red cellophane bag you received. It was also a visitor from afar. It had come from the Black Sea coast, from a place that has never known winter, from a place where it's always as warm as in a hothouse. That's why lemon and tangerine trees grow there, for they cannot survive the cold. They never shed their leaves like apple-trees or currant bushes, but stay green all the year round. There are tea bushes there also, planted in rows along the slopes of hills. Tea is made from the leaves of these bushes. There are groves of lemon, orange, tangerine, and pomegranate trees. When the pomegranate-trees are in bloom it seems as if there were red lights hidden among the leaves.

The blossoms of the lemon-tree are reddish, while orange blossoms look as if they were made of white wax. What a wonderful scent there is when the branches of the trees are bent under the weight of their fruit! There is enough fruit on one orange or tangerine tree to fill a whole lorry.

There were some biscuits in the little red bag. They had been baked in Moscow in a confectionery factory—baked from the flour that was made from the grain that had grown on a collective-farm field. There were hard toffees and chocolates in the little bag too. They had been made in a sweet factory. Ever so many people had to work before the apple and the biscuits, the tangerine and the toffees you like so much could come together in your little red bag!

Can you imagine what it would be like if you had to grind the grain and churn the butter for the biscuits, if you had to extract the sugar from a sugar-beet for the toffees, look after the apple-trees in Alma-Ata, and pick tangerines from the trees on the Black Sea coast? You'd have to be in many places at once and work with thousands of hands instead of two.

You don't have to, though, because gardeners, bakers, pastry-cooks, and railwaymen have all thought of you. All the nice things that were given to you had to be brought to Moscow from different places, and the last stop in their long journey was a large food store. You've often been in a store like this. The air in the fruit department was filled with the aroma of the orchards of the Crimea and the Caucasus, Alma-Ata and Tashkent. In the winter you marvelled at the huge fir-tree there.

You know all the departments in the store—the meat department, the fruit department, and the bakery department—but you have only seen half the store. There is another half which the shoppers never see.

When you walked around the store with your mother, it never occurred to you that there was another store beneath your feet, an underground one. Everything that is sold over the counters is first delivered up to them from under the ground. There are lifts in houses for people, and in stores

there are lifts too, lifts for apples, pears, flour, sugar, butter, and meat. When the counters upstairs begin to get empty, the lift brings up crates, barrels, and baskets of food. Beneath the meat department there is an underground meat department; beneath the fish department is an underground fish department, and so on throughout the store, each department having its own corresponding one beneath it.

If you were to go downstairs to the underground meat department you would think that winter had arrived in the middle of June. You would see white frost on the outside of the pipes running along the walls, and steam would come out of your mouth when you breathed—just like in winter. Why is it so cold there? The cold is machine-made. At home you have steam pipes which heat the rooms, but in the underground store the pipes make it cold. Machines pump a cold liquid along these pipes to cool off the surrounding air.

There are many people upstairs in the store: there are shop assistants behind the counters and customers in front of them. There are very few people in the underground store, as there are neither assistants nor customers. Work goes on there all the same. It is here that the food is prepared for sale: the sugar is weighed, the meat cut, and the fruit sorted and graded. A woman in a white smock puts tangerines on a board with holes in it. The small tangerines go through the holes, but the large ones don't. Why is she doing this? Certainly, not just for the fun of it. She is sorting the fruit according to size. It's hard to determine their size by sight, and it's very easy to make a mistake. That's why each one has to be measured, for the larger tangerines are more expensive.

In the dairy department the eggs are put into little cages. There's a light bulb under each cage, and the light shining through the egg will immediately show whether it is good or bad.

The butter, meat, fish, apples, pears, and grapes all have to be checked underground. If they have become spoiled on their way to the store, they will not be sent upstairs. They are tested for colour, for taste

and smell, and, if necessary, are even sent to a laboratory to be tested again. There are instruments in the laboratory which are much more sensitive than the human nose or tongue. They immediately determine whether or not there are any invisible fungi in the milk or butter which might spoil the products. The underground cold keeps the uninvited guests such as fungi and germs out of the store, because they can't stand the cold.

Did you ever eat frozen strawberries or peas in the middle of winter? The cold protected them from getting spoiled by keeping the germs out, and prolonged the summer till January for you, because you had strawberries in January, as if it were July.

The germs try very hard to get into the store. They find a way in by clinging to flies' feet or even get blown in on the air. Food must always

be covered to prevent the flies from touching it. At the same time, though, the products have to be displayed so that the customers can see them easily. How can such a problem be solved? For at one and the same time the food must be both covered and on display. It is solved by installing a glass case over the counter, which, while leaving the food visible, puts it out of reach of the flies.

Long ago there was a little shop where the big store now stands. It had a sign in the window that said: "Groceries." There were bars of soap next to the bread on the shelves, they sold candles and pies at the same counter, there was a barrel of herring next to the cider barrel, and the store was always full of flies. With each purchase the customer received a free bonus of flies. If you bought a loaf of bread you'd be sure to find a fly in it. If you took a sip of cider, there would be a fly in the cup. The sugar on the counter swarmed with flies.

They were having a feast in the window where the dried fish, sour cabbage, and pickles were displayed. Even though the flies were disease-carriers, the shopkeeper never bothered about protecting the food from them. He had only one thought in mind, and that was: how to make a bigger profit.

Nowadays the stores are run quite differently, for the Government is concerned with the customers' health.

The little grocery store has long since vanished, and even the two-storey brick house it was in has gone. There's a tall building in its place and the entire ground-floor of the building is taken up by a food store.

Germs don't always get into a store on flies' feet. People bring them in too, on their hands and on their clothing. You can't make a customer wash his hands every time he enters a store, but he can be prevented from touching the food. There's a rule that all the shop assistants must wash their hands thoroughly very often. And in a way they are like the people who work in hospitals, for they, too, wear white smocks and

caps. There's even a doctor in the store whose duty it is to see that the war against germs is being carried out efficiently.

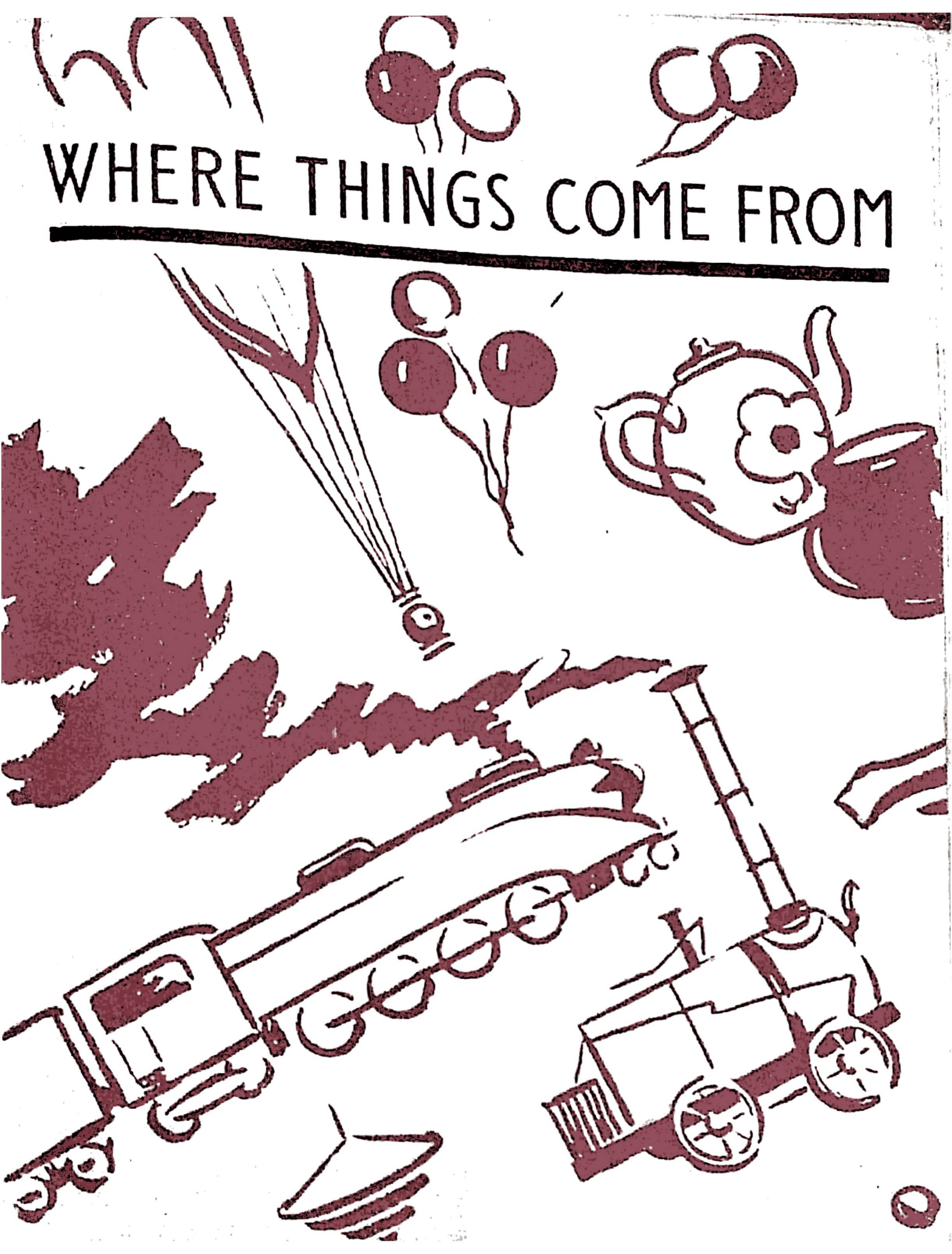
Nevertheless, a large store is really more like a factory than a hospital. Hundreds of people and many machines are at work. Vans deliver the goods to the store. One has the word "Bread" written on it, another "Meat," still another "Groceries." The crates, barrels, and sacks are transferred from the pavement down a moving belt to the underground warehouses. A crate of apples is put on a wide, solid, moving belt and is taken down to the underground department where the apples are stored. Machines cut up sides of beef. Upstairs, cash-registers print the sales-checks. You have seen a cashier press down the buttons of a register. A cash-register is a machine which prints a check, cuts it off from the roll of paper, and sends it out through a slot. At the same time, it also keeps track of the money it receives, and the little glass window on the top of the register shows the exact amount of the purchase.

What about the scales? It's really a clever machine, for it operates without weights and tells both the shop assistant and the customer how much it has weighed out. That's why it has two arrows and two dials, one in front and one behind. As soon as the assistant puts something on the scales the arrow starts off on its way. When you see it stop at the number "400," that means it has weighed out 400 grammes.

The store is busy all day long. Lorries carrying bread, milk, butter, apples, and sugar are streaming towards the store from the railway stations, from the docks, and from the factories.

Everything that is fed by the earth, watered by rain, matured by the sun, and produced by the labour of many people has been sent from all parts of the country and is gathered together in the underground warehouse.

WHERE THINGS COME FROM



YOUR PLAYMATES

You're not a little child any more. Every morning you get up early and go to school. You've learned to respect books, note-books, and coloured pencils, and you seldom remember your old friends, the toys, which have long since been locked away in the bottom drawer of the bureau. There they lie in a heap: your bricks, your top, your tumbler, and your old clock-work car. But you shouldn't desert your old playmates. They can still come in handy, for sometimes a toy can explain things just as well as a book. Have you ever seen a ship at sea? Even

YOUR PLAYMATES

You're not a little child any more. Every morning you get up early and go to school. You've learned to respect books, note-books, and coloured pencils, and you seldom remember your old friends, the toys, which have long since been locked away in the bottom drawer of the bureau. There they lie in a heap: your bricks, your top, your tumbler, and your old clock-work car. But you shouldn't desert your old playmates. They can still come in handy, for sometimes a toy can explain things just as well as a book. Have you ever seen a ship at sea? Even

the biggest waves can't knock it over, they merely make it rock and roll. When you make a little boat and sail it in a puddle or stream it usually turns over, because you never bothered to consult your tumbler. Why is a tumbler so stubborn? Why does it keep popping up every time you roll it on its side? Because it has an empty head and a heavy lead slug in the bottom. A ship is like a tumbler, only of course it's much bigger. A ship's hold, that is, its bottom, is purposely filled with heavy cargo, and light sailing vessels called yachts have cast-iron or leaden keels. That's why ships at sea don't capsize.

There's another stubborn fellow among your old toys, your top. If you spin it, it can keep on whirling around on its one foot for a very long time. And if you push it, it will only buzz angrily, straighten itself out again, and go on spinning until it has no more strength left. You might wonder of what use a top can be. It dances and turns, and that's all there is to it. But grown-ups as well as small children respect it. Scientists have written many books about the top, and engineers have been able to build many clever machines and instruments with its help. For instance, engineers put an enormous heavy top inside an ocean liner. When the top began to spin the ship hardly rolled on the waves at all. The top remained in an upright position and prevented the ship from rocking.

There was an inventor who even built a railway carriage that rolled along on one rail and didn't topple over. Why didn't it topple? Because a heavy top was spinning inside it.

Dig around in your heap of old toys and you'll probably find a faded hoop and stick. Remember how you used to run around after it, over pavements and paths and in places where there were no roads at all? As soon as you stopped hitting it, the hoop would fall over. But when you kept pushing it forwards with the stick it rolled along smoothly. People have made use of the hoop, too. A bicycle wheel is really just a hoop. In order to keep it upright you must push it forward all the time by pedalling.

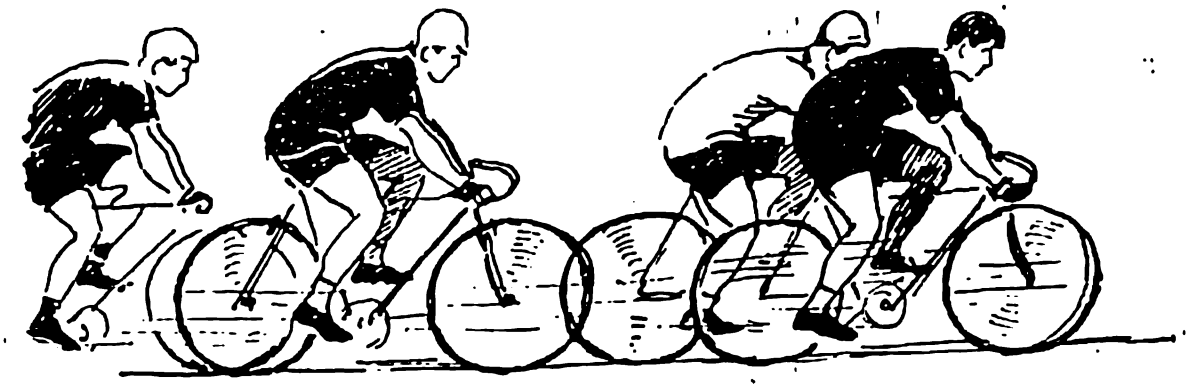
By some miracle, there's still a clock-work car in the heap of toys. It was a present you got when you were really very young. Remember how much fun it was to see it shoot out of your hands with a great buzz and head for the opposite wall? It was very stubborn and would never give anyone the right of way. Sometimes it would race straight towards the table. Anyone else might have taken a roundabout way, but not this car. It sped on towards the table as if it were saying, "Move, or I'll run you over!" The table was every bit as stubborn, and not in the least frightened. It stood its ground, and the disastrous end was always the same: the car would crash into a leg and turn over. But it would never concede its defeat. It would lie on the floor with its wheels spinning round in the air and keep on buzzing like a beetle until it had quite run down. In one accident it lost a wheel. Then the spring was overwound and broke. After that it could only move when it was towed along on a string.

However, even such an invalid can be of some use. If you take it apart and look inside you'll understand how it works. Not only that, but you'll have an idea of how a watch is made.

A watch and a clock-work car are closely related. A watch also has a spring instead of a motor. And it also has to be wound up before it will go. A spring is a tricky customer. No matter how much you wind it, it keeps unwinding. People know how to make use of stubborn things, and they said to the spring: "All right, you can unwind if you want to, but you might as well do some work while you're at it. Here's a little wheel with teeth for you to turn. It will catch on to another wheel which will move the hands of the watch. And the hands will tell the time."

There's a little wrinkled red bag in the heap of toys. In its youth it was a beautiful red balloon. Do you remember how you got it? You were out walking with your father and saw a man selling balloons on the corner. There was such a cloud of red, blue, and yellow balloons over his head that you even thought the wind might blow him away. You

chose the nicest balloon and tied it to your jacket button to prevent it from flying off. When you got home you untied it, and it escaped. It started bouncing along the ceiling instead of the floor, and you had to stand on a chair on top of the table to get at the runaway. They told you to fasten the string somewhere inside the house and let the balloon out through the window for the night, since the fresh air would make it live longer. But even then you were disappointed, because in the morning the balloon had shrunk a little. It didn't float high in the air any more. It only bounced around like a ball from the table to the bed, from the bed to the floor. It kept getting smaller and smaller all the time. You could not understand why it was that the balloon had once been able to fly and then, suddenly, could fly no more. But now you are quite big, and will understand it quite easily.



Balloons are filled with a gas that is lighter than air, and that's why they shoot up into the air like corks in water. But if the gas inside it escapes through a little hole, the balloon will shrink and will fly no more.

Your balloon never flew higher than the ceiling, but there are balloons which can fly very high, and are thus very useful to scientists. A box of instruments is tied to a balloon of this kind. The balloon is then cast off, and it flies so high that it soon gets right out of sight. The scientist is in his study, but the instruments in the box transmit the weather by radio and tell him whether it is cold, damp, or dry.

The balloon can fly much higher than men or birds have ever been. It's very cold so high up and it's extremely difficult to breathe, because there's not enough air. But instruments don't have to breathe and so they are sent up instead of people. When the balloon goes very high it bursts, but the scientists have thought of a way of preventing the box of instruments from falling right down below and being smashed. As soon as the box begins to fall, a parachute opens above it and the instruments float gently down to the ground. Sometimes they land in fields or get stuck in the branches of trees in the woods. But there is always someone to spot them. Sometimes children who have gone berrying or mushrooming come home with a curious box. They examine it from every angle until they notice the small piece of paper stuck inside, which tells them where to send it. That's how the travelling instruments get back to the place they started from.

Your little balloon has other relatives. These are huge balloons which are so powerful that they can even lift people. The people sit in a large basket or in a closed cabin with little windows.

The remains of a paper kite you once made yourself are at the very bottom of the bureau drawer. You used thin sticks for the frame and rags for the tail. Remember how your friend helped you to fly it? He held the kite and you ran ahead, unwinding the string as you ran. At first the kite didn't want to fly. It dragged along the ground catching on to the bushes with its tail and bobbing up and down. And then, when the wind caught at it, how gracefully it soared upwards, over your head, higher than the houses and the trees. It was pulling so hard you could hardly pay out the string quickly enough to keep up with it. Even though you were running along the ground, you were happy and felt as if you were flying along with the kite, for you had made it all by yourself.

The kite has helped science, too. It helped people to find out what was going on high above the earth. There were no radios then, and the scientists attached automatic writing instruments to the kite, which recorded the temperature and atmospheric pressure. When the kite landed, the scientists would take out its diary and see what the pens had scratched on the paper.

And the kite has been even more useful in another way. It helped man to build an aeroplane. People looked at a kite and wondered why it could fly, since it was heavier than air. That meant that it was also possible to use a kite for flying, and not only the basket of a balloon. So men started working on this problem, building and experimenting. Finally they built a glider, and then an aeroplane. A glider is like an aeroplane, except that it has no engine and cannot fly without a wind. If there is no wind to lift it and keep it up, it will fall. An aeroplane has an engine which drives the propeller, and the propeller is the screw that pulls the aeroplane forward.

In your heap of toys there are more bricks than anything else. They're all colours and sizes. Remember how many houses and forts you used to build with them! At first your houses would collapse when you tried to make them taller. You used to put big bricks on top of little ones, and usually at an angle, at that. But then you got the knack of it, and amazed everyone by building twelve-storey towers which didn't topple over. And all because you had learned how to place the bricks and make the tower steady.

People who build tall houses and towers must also make sure they will be firm and steady.

You had other toys, mostly those which you had made yourself, and many of them haven't survived. One of them was a paper pin-wheel which you stuck on a stick with a pin. When the wind blew, the vanes spun round very fast. This paper pin-wheel shows you how the wind turns the sails of a real windmill and how steam makes the wheel of a turbine spin around.

See what other toys you can dig up, and try to find out if they have a story to tell you, too.

MACHINES YOU HAVE AT HOME

There are not only machines in the street or in the factory. You have some at home, too. Look around carefully. There's a sewing-machine on the table near the window, and your mother knows how to use it. Perhaps you have sometimes fallen asleep listening to its steady hum. Now and then it would stop without warning and then suddenly hurry on its way again, increasing its speed as it went. The moment of silence

would wake you and the steady hum would lull you back to sleep again. In the morning you'd discover that your mother had made you a new shirt. So you see, the sewing-machine had not been humming away in vain.

You know the make of every car in the street and won't be impressed by a mere sewing-machine, but your grandmother and great-grandmother considered it quite a miraculous invention. And no wonder, for here was a machine that could sew so very quickly, and all by itself!

When you sew by hand the needle dawdles along the white linen road of a shirt or a sheet. You can't even compare it to a sewing-machine. The difference between a sewing-machine and an ordinary needle is as big as it is between a car and a pedestrian.

Have you ever turned the wheel of your mother's sewing-machine for her? Even though you didn't turn it very fast, the needle kept flying up and down, up and down, and the spool of thread kept spinning round, feeding thread to the needle. Each second the needle would jump ten times and take ten stitches. Jump, jump, jump, jump, jump, and before you knew it, the needle had reached the edge of the sheet and was turning the corner on to a new, untravelled path.

It's easy to sew like this if you know how, but it wasn't so easy to invent the sewing-machine.

Do you realize how many parts there are inside? When you turn the wheel, all these parts begin to move, like so many little hands and fingers. The most interesting part, however, is the shiny shuttle. Steel fingers steer it and the little bobbin of thread inside it. The needle and the shuttle work well together, and together they sew through the material with two threads at once instead of one at a time. They move so quickly that it's hard to follow them with your eye, but if you try very hard, you can.

First, the needle pierces the fabric and pulls the thread downwards. Then the needle goes upwards and pulls the thread up after it, forming

a loop. If it were not for the shuttle, the needle would be working for nothing, as it would make loops and rip them out as it went along. A machine that sews and rips its own work is not of much use. This is where the shuttle comes in. It prevents the needle from ripping out the loop. As soon as the needle makes a loop, the shuttle catches it from beneath with another thread. When the needle wants to pull the loop out, it can't, for the second thread has a tight hold on it and won't let it slip out of the fabric. And so the needle and the shuttle work in harmony, sewing with two threads. The needle skips up and down, making a loop and pulling it tight at each step. The shuttle races back and forth beneath it, catching each loop and securing it.

The little sewing-machine you have at home has many sisters which are run by powerful motors. They work in factories and each one has its own job. Some stitch dresses or coats, others sew on buttons, still others make button-holes and bind them. There are sewing-machines which sew fur coats together and others which stitch leather boots. Some sew up flour sacks and stitch heavy canvas.

A sewing-machine isn't the only household helper we have. There are others too: for example, a vacuum cleaner. It looks like a strange animal with a long trunk. This strange little monster moves along the rug buzzing and sucking in the dust through its trunk. The noise is made by the fan which breathes in the dust-laden air. The dust is trapped inside the vacuum cleaner, but the clean air passes through the machine and out the other end. At home a broom does a very good job of cleaning, and no wonder, for the ancient clan of brooms has been busy at its trade for hundreds of years! But in a club or a hotel where there are many rooms and many rugs, cleaning is a problem. And that's where a vacuum cleaner can shine in all its glory.

The vacuum cleaner really has a big job in the Metro, and the vacuums there are huge. They rumble along the underground halls, and wherever they have passed the floor is cleanly swept, the dirt and dust have vanished.

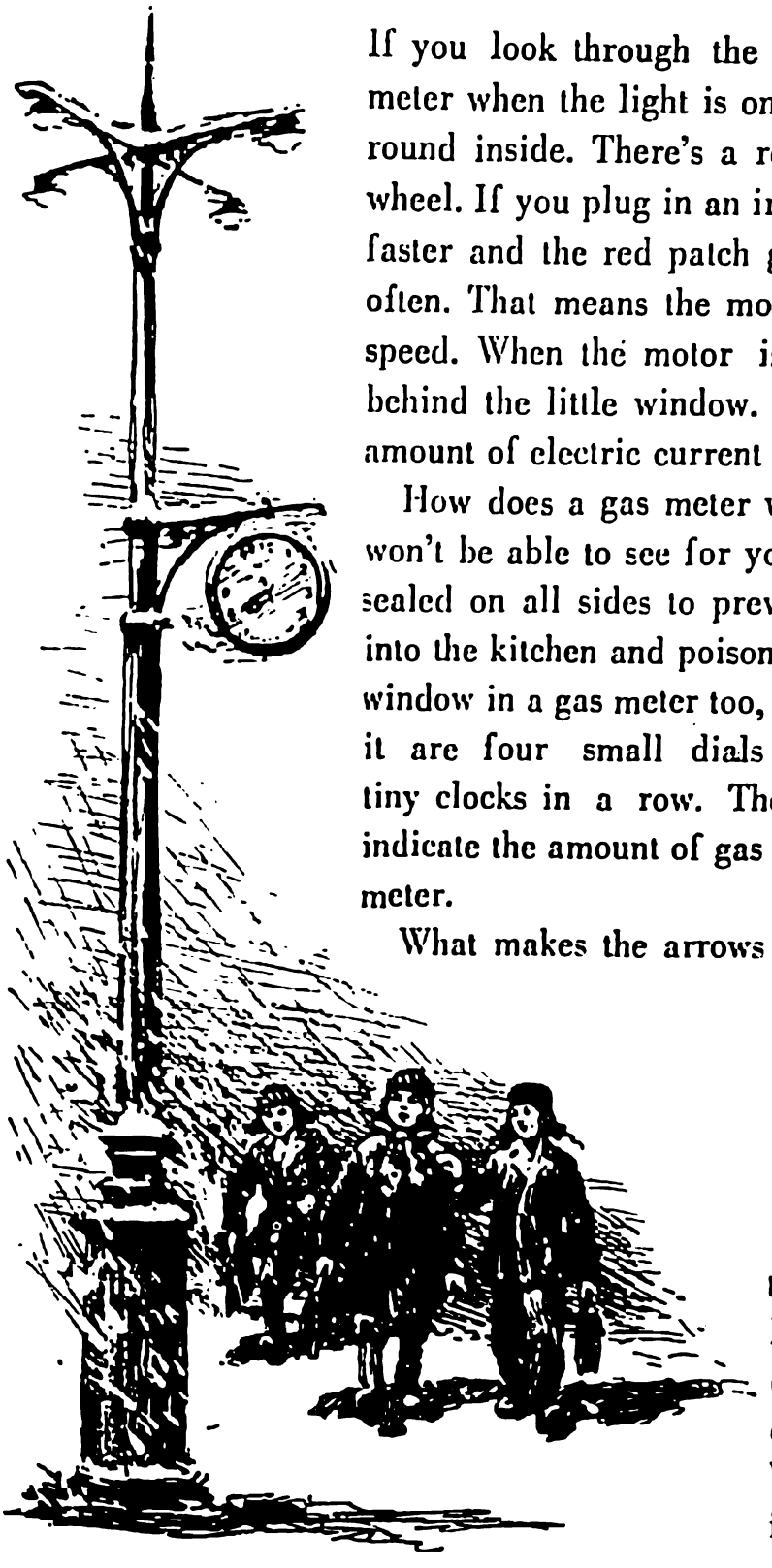
Let's see whether we can think of another machine we have at home. There's the typewriter.

When you write with a pen the lines and letters don't always obey you. If the paper is not ruled, your lines go uphill and downhill. The letters lean forwards and backwards. One "a" comes out fat, and another so skinny that it looks quite starved.

A typewriter knows how to make all its lines straight, all its "a's" the same height and shape, just like soldiers in a row. A pen has to outline each letter carefully, but the machine writes a letter with a single blow. And at the same time it moves the paper up and rings a little bell which says, "The line is ending, it's time to start another one!"

If you like machines, you've surely tried to discover how the carriage works and how a key can make a crooked little hammer hit the paper. Perhaps you even asked yourself, "What makes the carriage move?" A car has a motor and a watch has a spring, but what kind of an engine does a typewriter have? All you have to do is touch a key with your finger to make the carriage move to the left. Do you know that a typewriter has a spring, just like a watch? This spring, plus your own ten fingers, make the typewriter tap away with its little hammers and move the paper along. A typewriter writes better and faster than you do. But even a typewriter can make a mistake. If you spell "cow" with an "a," the typewriter will write "caw" for you. For however clever it is, it still does not know how to spell.

There are two instruments which can be found in any house that has gas and electricity. They are called meters. They don't know how to write, but they do know how to count, and they never make a mistake. The electric meter keeps track of the amount of electric current being used in the house, and the gas meter keeps track of the amount of gas that is burned. The meters know exactly when you turn on the light or the gas. If you put your ear close up against an electric meter you will hear a faint buzzing sound. That's the small electric motor inside it.



If you look through the little glass window on the meter when the light is on, you'll see a wheel turning round inside. There's a red patch on the rim of the wheel. If you plug in an iron, the wheel begins to turn faster and the red patch goes by the window more often. That means the motor is working at a greater speed. When the motor is on it turns up numbers behind the little window. These numbers show the amount of electric current that has already been used.

How does a gas meter work? That's one thing you won't be able to see for yourself, because it is tightly sealed on all sides to prevent the gas from escaping into the kitchen and poisoning people. There is a little window in a gas meter too, but all you can see through it are four small dials with arrows, like four tiny clocks in a row. The arrows move round and indicate the amount of gas that has passed through the meter.

What makes the arrows move? If something interests you, you always try to look inside and see how it works. If you could look inside a gas meter you would see two bellows, like those in a concertina. As the gas passes through the bellows, it puts pressure on their sides and inflates one or the other of them. Why is this strange concertina-playing necessary? Not

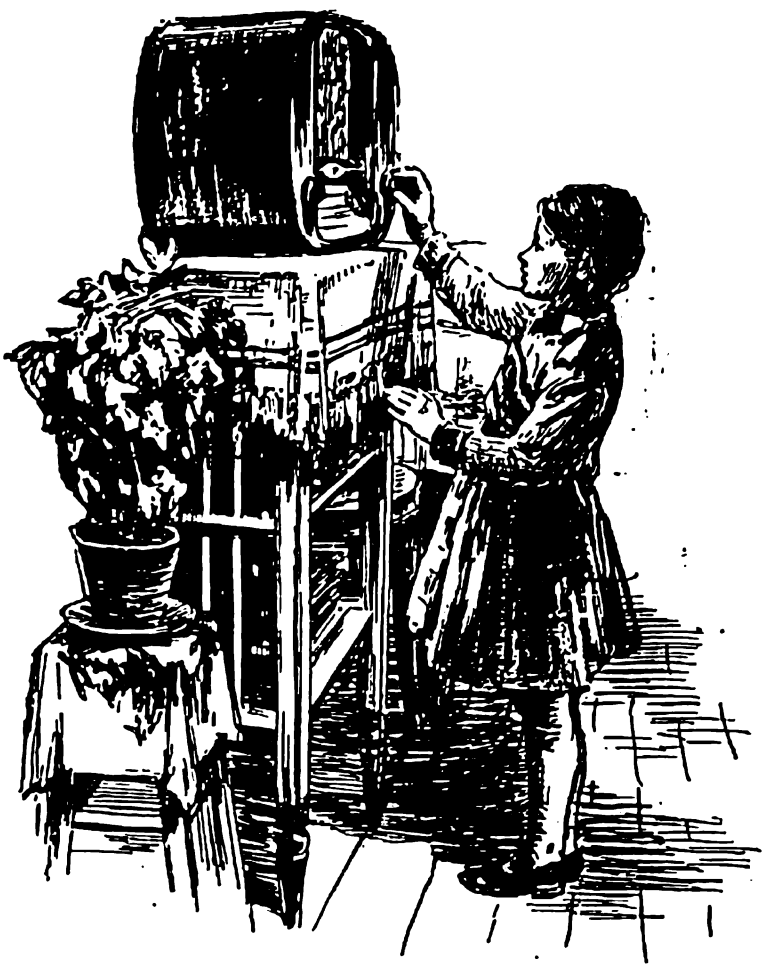
just for the fun of it! This is how the gas is measured and the arrows are moved round the dials.

We have talked about clocks many times already, but if you think for a moment, you'll realize that a clock is also a meter. It measures time. A spring makes the cog-wheels revolve, and they, in turn, move the hands. But the main spring would unwind in an instant if it were not for the clock's pendulum. The pendulum swings backwards and forwards and halts the movement of the cog-wheels at every swing. That's why every clock has a curved plate resembling an anchor. It's even called an "anchor." When the pendulum swings, the anchor swings too, and the left and right pallets of the anchor alternate in coming between the teeth of the escape-wheel. The escape-wheel is so called because it directs the movement of all the other cog-wheels in a clock. Big clocks with pendulums are constructed in the same way. A watch has a little wheel with a spring as fine as a hair instead of a pendulum. The spring coils and recoils and makes the little wheel turn backwards and forwards. This movement of the little wheel causes the anchor, which is attached to the wheel, to swing from side to side, lowering its right or left pallet, and thus holds back the escape-wheel. That's why a clock ticks. When the anchor hits a tooth of the escape-wheel with its left pallet, the clock says "tick"; when it hits the wheel with its right pallet, the clock says "tock."

It would be difficult to live without clocks. You'd be late for school and forget to go to bed at night. You'd either get to the theatre or the

cinema too early or after everyone had left. Without clocks, nothing would run smoothly anywhere. Trains would run at all hours instead of on schedule. Factory machines would work in complete disorder. It's hard to imagine how difficult things would be without clocks. All our lives pass by to the sound of their steady ticking. You are awakened in the morning when your alarm-clock says, "Get up!" And you are sound asleep when the radio transmits the midnight chime of the Kremlin clock.

Clocks help us save time as well as measure it. There's a saying which goes: "A penny saved is a penny earned." It could just as well be put another way: "A minute saved is a minute earned." If you save a minute here and finish a job a minute sooner there, before you know it, you'll have an hour saved from all these minutes by the end of the day. In a year's time these hours saved will amount to weeks and months. And over a period of five years you can save a whole year or even more from all these weeks and months.



Have we mentioned all the machines and instruments in a house? No, we've left some out. There are instruments which seem to carry you over hundreds of miles. You can be at home and speak to a friend who lives in another city. Or else, you can listen to music played by an orchestra at the other end of the country.

You've already guessed what these instruments are. One is the telephone and the other is that dear old friend of yours, the radio. You'll learn how the telephone and radio work later, when you are older. They are very complicated and in order to understand them you must first get to know a science called physics.

When you dial a number on your telephone you set an automatic machine in motion at the telephone exchange, which connects you with the number you dialed.

A radio may be in perfect order, and you still won't be able to hear a story or a band over the air. The radio station has a part in it too. It is the radio station that transmits the music and dramas from the radio studio to your home.

WHERE THINGS COME FROM

Where did your tea-cup, your table, and electric bulb come from? Where were an aeroplane, an automobile, a telephone, and a railway engine born?

In factories.

To make the most simple thing, you need instruments. You cannot make a table or shelf without a hammer or a saw, and huge, complicated machinery is needed to make an automobile or a locomotive. You can find a hammer and a saw in any carpenter's shop, and even in your own home, but if you want to see the machinery that makes automobiles or locomotives, you must go to a factory. If you ever have a chance to visit a large factory you'll see the many marvellous machines that help people in their work. You'll see enormous scissors that cut sheets

of iron as if they were paper. You'll see a wonderful hammer which forges iron all by itself; all the smith has to do is to keep an eye on it. There's a magic furnace there too. It heats up by itself and opens and closes its own doors. There are two lights over the furnace: a red one and a blue one. If the furnace begins to cool off, the blue light flashes on. If it gets overheated, the red light flashes on. This is how the furnace tells the stoker, "I'm hot," or "I'm cold."

Everything in a factory is organized so that the job of the workers is made easier. When parts have to be sent down to the floor below, they are put on a chute and they slide down one after the other, just as you slide down a hill on your sled in winter. A road made of rollers awaits them at the bottom, and after a light shove, the parts move along the rollers. There are little electric platforms on wheels in the factory and they're like little trolleys for the heavy parts. The worker turns the starter and off it goes down the asphalt floor. You'd really enjoy such a ride.

Perhaps most interesting of all is an automobile factory. You'd see a huge hall there with machines filling up most of the space in it, as if they were houses in a city.

The machines are bigger than a man. A person has only two hands, but a machine has many hands and each hand holds an instrument. There are passages between the machines, just like streets. The parts of a future automobile move along these streets in long columns. They ride on electric cars, they move along roads made of rollers, and they slide down chutes.

The parts all ride, roll, and slide in the same direction towards the city's main street. On the way they stop off at each machine, as if they were dropping into a house for a visit. In one place the parts are milled, in another they are turned, and in still another they are polished. There's a worker in charge of each machine: a turner at the lathe, a miller at the milling-machine, and a driller at a drill.

The worker presses a button and the drill starts up. It has a firm hold on the metal to prevent it from slipping. Steel drills are lowered from above and in a second they have drilled several identical round holes in the parts. The worker presses another button and the drills are lifted up again.

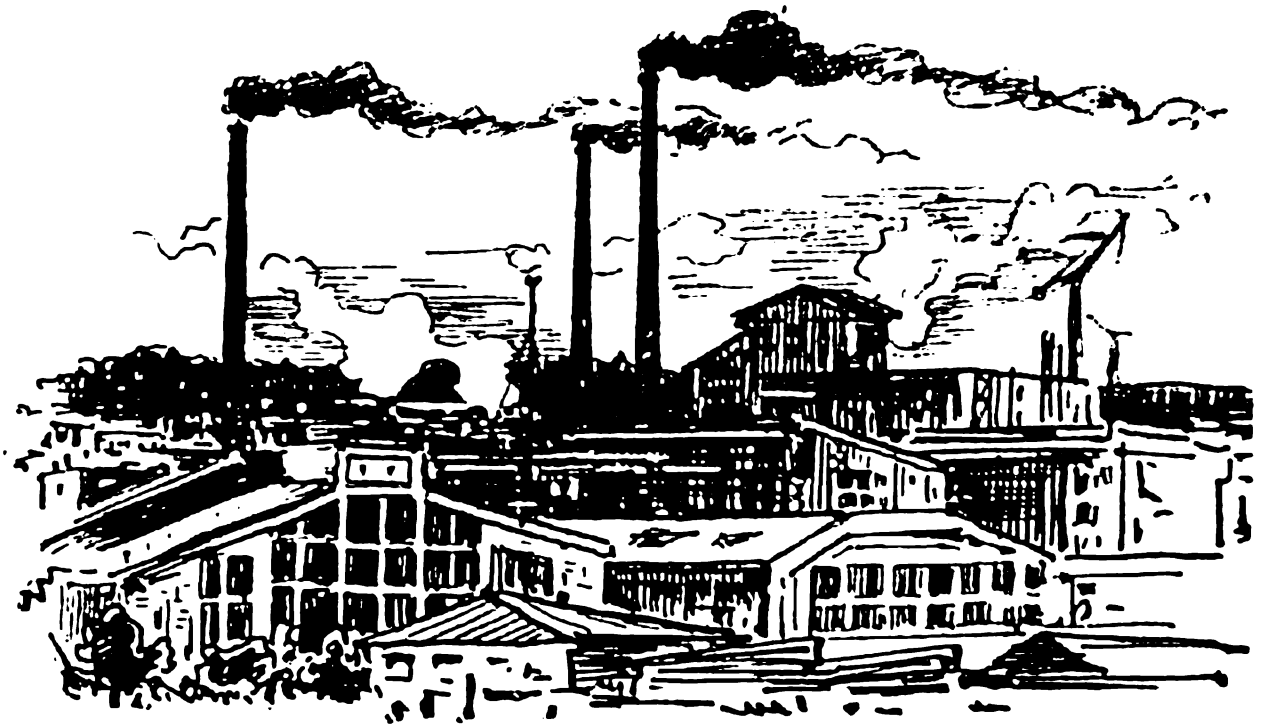
And so each part travels along the road, changing its appearance as it goes. When it reaches the main street of this city of machines it is exactly the right size and shape.

A piece of metal has been transformed into an automobile part. Do you realize how much a person has to know and how clever he has to be in order to operate one of these big and complicated machines! Each part must be made just so. Apart from this, the work has to be done quickly, so that no time is wasted needlessly.

There are famous workers in the Soviet Union whose names are known to everyone and who operate their machines at speeds unheard of ever before.

An automobile is put together from parts rather like you would build a house from toy bricks. A wonderful road called an assembly line stretches along the whole length of the main street of the machine city. It is a wide steel conveyer belt on wheels. The wheels roll on rails and move the steel belt. An ordinary road stands still and the traffic moves along it. But on this road the traffic stands still and the road moves along!

A rectangular frame is put on the conveyer belt at the beginning of the assembly line. It doesn't look like an automobile at all. The frame moves on from one worker to the next and each one does something to it. One adjusts the front wheels, a second adjusts the rear wheels, a third attaches the steering-wheel, and a fourth puts in the motor. By the time the frame reaches the end of the assembly line, it has become a full-fledged automobile like any other car you can see in the street. It is ready to roll off the conveyer belt. A driver gets behind the wheel and the shiny new car proudly leaves the factory to start its working life.



People worked hard to put it together, and now it can repay them in kind and work for them.

There are many nimble, able, and clever machines. Scientists and inventors are constantly finding new ways of making machines work faster and produce an abundance of everything; they are finding new ways of making work easier for the farm workers, the factory workers, the miners under the ground, and the bricklayers up on the scaffolding.

No matter how good a machine is, it cannot get along without the help of man, for it has no mind of its own. The person who is in charge of it has to do its thinking for it. Even the best of machines will get lazy if it falls into bad hands, but it will work better each day under the care of a person who knows all its ways and takes good care of it.

If things could talk, each little part of an automobile or a locomotive, a typewriter or a radio could tell you all kinds of interesting tales about its journey through the factory from one worker to another. It could tell you how the workers tried their best to make it, how they competed among themselves to see who could work the fastest and produce the most in a day. But the whole idea of a competition is not just to see

who comes out first. It's to encourage each worker to advance himself and help those of his comrades who are lagging behind. A whole book could be written about the way our workers compete among themselves in inventiveness, resourcefulness, and persistence, while helping each other and increasing their own knowledge of their trade.

There's a lot of work and thought behind every object that surrounds us. Iron, wood, clay, glass, wheat, cotton, wool, leather, and rubber change hands many times before they are transformed into cups and saucers, buns, dresses, shoes, shirts, tables and chairs, books, houses, cars, and machines. Each transformation seems like magic. But magic only exists in fairy-tales. A great deal of knowledge and skill is put into the job of building a car, of making a note-book from wood, or a china cup from clay.

Cars, aeroplanes, note-books, china, telephones, locomotives, cranes, and steel-cutting scissors have all been made with the help of science and hard work.

WHAT FROM WHAT

You're a curious person and whenever you see a new thing, you always ask, "What is it made of?" Sometimes it's easy to answer such a question: a table is made of wood, a ball is made of rubber. Some things, however, do not resemble the materials they were made of at all. A pitcher has little in common with clay. To change clay into a pitcher it first had to be moulded into the shape of a pitcher, and then fired in a kiln.

Does a book look like a fir-tree? It probably never entered your head that your mother's best silk dress and your favourite book were both

made from a fir-tree! And what about your rubber boots? You'd never believe it if you were told that they were made from sawdust. But if you go to a chemical plant you'll see how alcohol is derived from wood sawdust and rubber from the wood-alcohol. Rubber is also made from the juice of a Russian dandelion called "kok-saghyz" and several other plants. Artificial silk is made from wood and real silk from the cocoons of silk worms.

In other factories and plants you can see plastics being manufactured from coal or oil, and telephones, plates, combs, cups, buttons, electric switches, and many other things being made from plastics. You could see how artificial leather is made from wood or oil and cottage cheese is transformed into artificial wool.

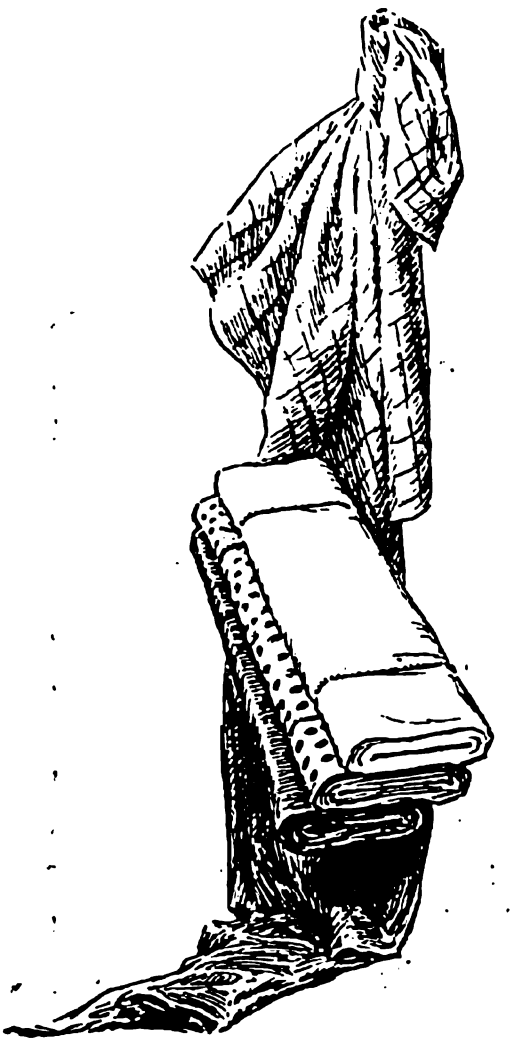
For instance, take your own shirt. What could be nearer to you than the shirt on your back? Your coat, socks, and gloves are the friends that keep you warm in winter. But where did they come from? What are they made of and how are they made? You probably never even thought about it at all.

There was a time long, long ago when there were no houses and people lived in caves or tents. They sewed their clothes from animal skins. They had bone needles instead of steel ones. People didn't know about steel in those days.

At home your mother's needle and thread and the material cut out for sewing all live together on the sewing-table, but they are not the same age. The needle is much older than the thread or the material. Thousands of years went by before people learned how to sew their clothes from materials instead of skins.

In order to weave the fabric they first had to spin the thread. But they had to have wool to spin thread. When people tamed wild sheep and domesticated them, they realized that there was a better way of getting clothes than just killing a sheep and skinning it. A sheep could only be skinned once, but it could be shorn of its fleece every year.

A thread just as thick as was needed could be spun from the wool, and ever so many things could be made from the thread. Perhaps you know how a spindle works. The spinner takes a bundle of wool and pulls out several long fibres, twists them between her fingers and ties them to the spindle, a round wooden stick which is thicker in the middle than at the ends. A spindle gets its name because its task is to spin, or twist the thread, which has to be twisted so that it will be smooth and strong, for if you just pull the fibres out of the bundle of wool they will tear easily. The spinner twirls the spindle round and winds the thread on to it. If you want to see what an old-fashioned hand-loom looks like, you will have to go to a museum where such ancient things are preserved.

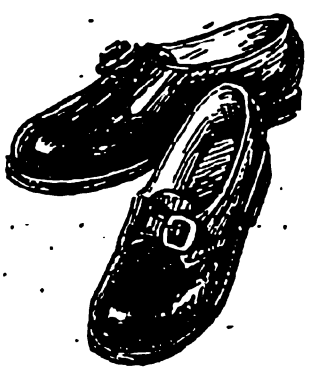


A hand-loom is quite simply built. It is made of a frame of four wooden rods. Between the top and bottom rods are rows and rows of taut threads. The weaving is done by pushing other threads across the down-threads. Cloth is woven from thread just as a basket is woven from rushes. You can even make a loom like this for yourself. Turn a four-legged stool upside down and tie several pieces of thin string lengthwise between the cross-bars. This will make the threads which we call the "warp." Now

you must pull a thread through them crosswise, making what we call a "woof." To do this you pick up every other down-thread, the first, third, fifth, and so on, and pull the string through them crosswise. Then go back the way you have come, picking up the second, fourth, and sixth threads of the warp, and pull the string through them, too. And so you go on. This will give you a woven fabric. It will be a clumsy string one, not like a piece of wool or cotton, but that's not important, as you won't have to sew it into anything. The main point is that it will help you to understand how real fabric is made. Hold a piece of material up to a light and you'll see that it's all made up of criss-crossed threads.

Of course, they don't weave on stools in weaving factories. They have large electric looms with a huge roller on each side. One roller supplies the loom thread, or yarn, and the woven fabric is wound on to the other. The cross-thread is carried backwards and forwards by a fast-moving shuttle. When all the yarn in a shuttle is used up, the loom itself supplies a new shuttle. If the thread breaks, the loom stops automatically and waits for the worker to come and knot the pieces together.

There are many skilled workers who operate many machines at a time, and each one of them can proudly say that thousands of people wear the fabrics that he, or she, has woven.



Yarn is also spun on high-speed machines. Otherwise it would be impossible to clothe every-

body, for you can imagine how much yarn must be spun in order that every grown-up and every child, both big and small, can have clothes. There are so many people in the Soviet Union that it is hard to count them all. That is why so many cities have large spinning mills and weaving factories. In these factories wool, linen, cotton, and silk are transformed into heavy rolls of plain cloth and printed cloth, light and thick, cloth for winter and cloth for summer.

Let's have a look at your shirt, for example. What is it made of? Cotton. And where does cotton come from? In some parts of the Soviet Union the summer is very long and the sun is very hot. There are bushes in the fields which bear strange fruit. Each fruit is like a tiny seed-box, and in the seed-box are seeds covered all over with fuzzy hair. This is the cotton bush, and cotton is made from the hairs of the seeds. How do they make cloth from cotton? First of all, the hairs have to be separated from the seeds and then the cotton has to be combed and smoothed. In a barber shop people have their hair combed and smoothed with combs and brushes. There are combs and brushes at the cotton mills too. These brushes have steel bristles and are machine-operated.

After the cotton has been brushed, it is sent through a machine with a round opening, and it comes out in a thick loose ribbon. This ribbon isn't strong at all, but a thin strong thread must be made from it. To do this several ribbons are joined together. Then they are stretched until they become longer and thinner, rather like a thick string, which we call a rove. To make the rove even stronger, it is twisted. All this is done by machine, on automatic spindles. There are thousands of these spindles in the machines and the whole mill buzzes like a beehive from their spinning.

The yarn is then taken to the weaving factory. We have already had a look in there and we know how cloth is woven from yarn. Finally, the fabric is ready. But it's not very pretty. It is a sort of yellowish colour. You can't make shirts from cloth like this. It must first be cleaned and made more presentable, and so it is taken to a third factory, called a

printing factory. There the cloth is bleached and washed, and coloured stripes, polka-dots, or flowers are printed on it to make it more attractive. There are artists at the factories who create new patterns and colours for the cloth. You have probably seen how a rubber stamp is used on paper. In the mill the stamp is made of copper rollers which are not flat but round. They could be rolled backwards and forwards over the cloth to print the pattern as a rolling-pin is rolled over dough, but this is not very convenient. It is much easier to do it the other way round, that is, to pull the cloth over the rollers. And that's how a printing machine works.

The printed cloth is delivered to a shop and is sold. Some people make shirts from it, some make dresses, some make kerchiefs. Then you find that the blue stripes on your sister's dress are the same as the ones on your shirt, because your mother made them both from the same piece of material.

This is the story of your shirt. In an old book it says that a shirt was grown in a field, and it's true, for it is made of cotton and the cotton grew in a field. While we are on the subject of your shirt, let's go back to very ancient times, when clothing was made from skins. People wear skins nowadays too, but they're not prepared and made up the way our ancestors did theirs. Your winter hat and the collar on your winter coat are made from rabbit-skins. And your feet are covered with animal skins too. You know, of course, that your shoes are made of leather and that leather is made from calf or goat skin.

How does an animal skin turn into leather? There's really not much resemblance between them at all. A skin is covered with fur, but you'll never even see a hair on leather.

Shoes can never be made from a raw hide, for it isn't strong enough and isn't supple at all. If it's exposed to the air it will start to rot, if it's dried it will get brittle. Therefore, to turn into leather, hides must first be dressed in a tannery.

There are just as many different kinds of machines in a tannery as in any other factory. A hide is washed and soaked to make it softer; then it's scraped and soaked in acid solutions to make the hair come off it easily. When the hair has been removed, it is quite bald and is called an unhaired hide. But this unhaired hide is still not leather. To make it strong and solid it is tanned. That means it is saturated with a solution made from oak bark, or with a similar solution. Leather is often tanned in salts of chromium. This salt is green and turns the leather green, too. We call it chromium leather. Perhaps you already know that there are "chromium boots." Since no one wears green boots, it is obvious that the green leather has been dyed. After dyeing, it is dried and polished. Then the tanners have finished with it. They send the leather on to a shoe factory. There it travels from worker to worker, from machine to machine again. There are very many machines that help the workers make a pair of shoes. One machine cuts out the leather to a pattern; another stretches it over a last; a third sews it; a fourth puts on the soles; a fifth punches holes for the laces and a sixth shines the shoes. Finally your new shoes are ready. They are soft and strong, and attractive.

A TEA-CUP, A CROCK, AND THEIR RELATIVES

A crock is no great beauty, but it really looks drab beside a pretty and delicate tea-cup, or beside a pot-bellied tea-pot with its nose in the air. However, a crock does not very often meet the tea-cup or the tea-pot. The porcelain tea-pot lives with the sugar-bowl and its numerous family of cups and saucers on the top floor of a beautiful house called a china cupboard. The lowly crock hardly ever gets beyond the kitchen door.

Neither the tea-pot nor the pretty cups which sit on a shelf in the china cupboard should be so haughty when they meet the crock, for it is their relative, and the oldest member of the family, at that.

This family is very big, indeed. The tea-pot and the plate, the brick and the roofing tile, the white insulator on a telephone pole and the china bowl in the chemist's shop or laboratory, the huge decorated vases in museums, and the Dresden china figurines on the mantelpiece—all these are made of clay and trace their ancestry back to the first earthenware cooking pots.

A thousand years ago no one had ever heard of the china tea-pot, for porcelain had not yet been discovered, although there was plenty of crockery everywhere. When scientists dig among the ruins of ancient dwellings and ancient burial-mounds, they often find pieces of pottery and sometimes even whole bowls, jugs, and pitchers. There are crocks among the most ancient finds. They existed in the far-off days before any of today's china cupboard dwellers had been born. There were no spoons or forks, and knives were made of stone, because no one knew about iron.

The scientists in charge of diggings get excited about every piece of crockery they find and examine it from every angle. From these pieces of crockery they try to imagine what the whole vessel looked like in the days when it belonged to some ancient hunter's or fisherman's family.

Some of the pieces of crockery have finger-prints on them. These were very important discoveries, for the scientists were able to determine whose hands had made the first crude jugs that are the ancestors of the many beautiful and useful things we have today. Many hands touched the ancient pot during its long life, but the only traces found are the finger-prints left in the clay the very day it was made, after it had been moulded into shape, but before it had been fired.

There are many sciences and one of them is the science of finger-prints. You probably know that no two people have the same finger-prints, and through this science we learn that most ancient pottery was made by

women. In those days the housewives themselves made the pots and bowls in which they cooked and stored food.

There's an old Russian proverb which says: "It's not gods who fire the pots," and it means that you should never be afraid of difficult or complicated work. It was no easy job to mould and fire a pot. First of all, clay of the right consistency had to be found. When it was brought home it had to be dampened and kneaded over and over again to make sure that no lumps were left in it. Then the damp clay was rolled out into long snakes of the same size. The long pieces were joined together and put on a board, then wound higher and higher in a spiral. The hardest part was to even out the pieces and the seams between them, to assure a smooth-sided vessel. When this was finished, a round clay bottom was attached to it. When the pot was ready, the housewife would take a sharp stick or a bone comb and draw lines across the still damp clay. A pot was not a pot without such a design, made up of straight and wavy lines. The pot then had to be dried, but that was not the last step. All this work would have been quite useless if anyone had decided to use the pot and had poured some water into it, for it would have melted away into a lump of wet clay. In order to prevent such a thing from happening, the vessel was fired after it had been dried. A wonderful change took place in the process of firing: soft clay would become as hard as a rock, and no rock will ever melt in water. The firing had to be done skilfully, to prevent the pots from cracking or crumbling.

Finally, the newly-baked pot was ready to start its life's work. Since it was a cooking pot, its place was in the oven, cooking soup or meat. It was not very well made—there would be a bump on one side and a dent on the other, and the rim would be rather uneven. Obviously, it had not been thrown on a potter's wheel.

The potter's wheel was invented much later, when there was a great need for it, when people had stopped making their own pots and used to order them from potters, or get them at the market in exchange for grain, milk, or honey.

As harvests became more abundant and the herds of cattle larger, the demand for pottery also grew. And so the trade of the master-potter grew up. He would be able to make enough pots to supply his whole village in the few winter months when he was free from field-work.

If there was a city near by the potter would load his painted pots into a small boat and take them to market. It was safer to transport his fragile wares by water rather than by cart over the bumpy roads.

Potters invented the simple potter's wheel, a very clever invention that speeded up their work.

First, let's take a look at its construction. A little wooden peg was secured in an upright position at the very edge of a bench and round this axis spun a heavy wooden wheel. The potter would straddle the bench, spinning the wheel with his left hand and shaping the damp clay into pots, bowls and cups with his right. It was no longer necessary to keep turning the bowl, it revolved by itself on the wheel, becoming even and round under the potter's steady hand. The potter's wheel has survived right up to the present day although it has changed somewhat. Nowadays, it is run by a foot treadle instead of by hand.

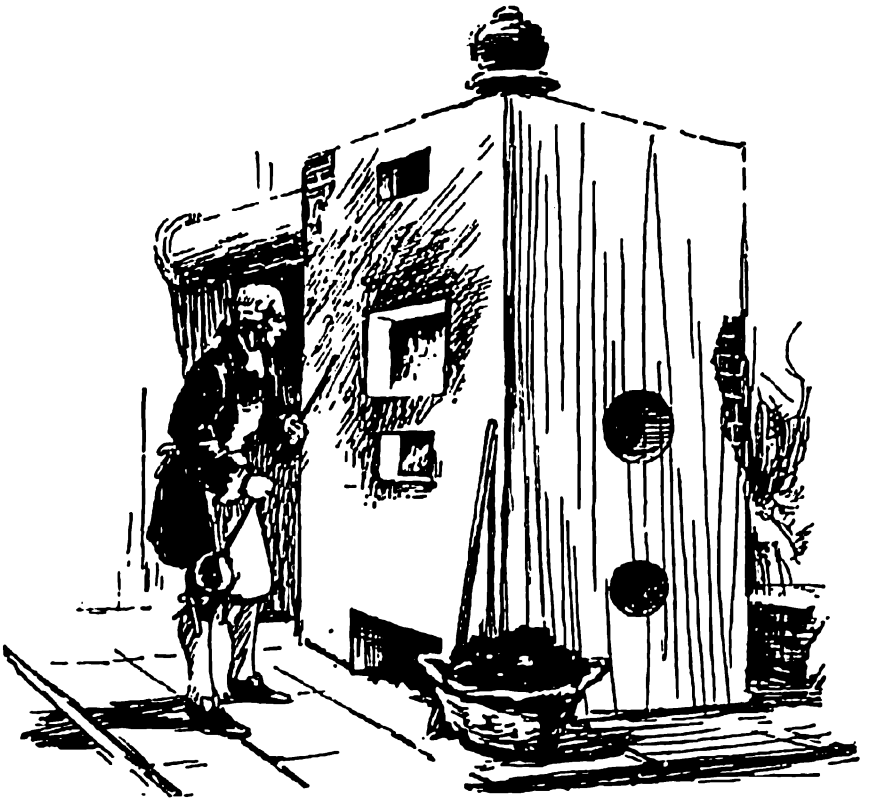
There were potter's wheels in Russia very long ago. Soviet scientists have found pottery made on a potter's wheel a thousand years ago in excavated burial-mounds in the regions of Kiev and Smolensk.

In some places parts of kilns have survived. In ancient times housewives used to fire their pottery in an open fire or a hearth, but later on potters invented a much more effective oven, called a kiln. Ancient toys made of baked clay have also been found among the pieces of pottery. There were whistles and rattles, and horses and sheep, and strange animals with bearded human faces.

It's really amazing how all these fragile clay horses and whistles could have survived through the centuries under layers and layers of earth.

It's difficult to say exactly where the first potter's wheel and kiln were invented. Most probably they made their appearance not just in one country, but in many countries as was the case with porcelain many centuries later. The secret of making porcelain was discovered several times in different places. The Chinese were the first to produce it. They mixed a white clay called kaolin with powdered stone and water and threw pottery made from this mixture on the potter's wheel. The mixture of clay and stone had to be fired at a very high temperature to make it into porcelain. A thermometer with which you take your temperature goes as high as 108° F., but the temperature in a porcelain kiln has to be 2732° F.! Such heat cannot be measured by an ordinary thermometer, for the glass would melt and the mercury evaporate. The composition of the clay and the firing of the porcelain are very important, as the chinaware must not melt or lose its shape under the tremendous heat.

Porcelain does not resemble the clay it's made from at all. Clay can be kneaded by hand, but you can't even cut porcelain with a knife. Earthenware is porous, because there are pores left between the particles of clay when the water evaporates out of it during the firing. Porcelain, however, is all caked and melted and



has no pores at all. Clay is not translucent, but porcelain is.

The Chinese didn't want anyone to find out the secret of the wonderful transformation of clay into porcelain, because they were afraid of losing their great profits. A porcelain cup is an object of everyday use to us, but in olden times it was nearly worth its weight in gold. Porcelain was so rare that there was a time when fashionable European ladies wore bits of broken cups on chains around their necks, like jewelled pendants. It was nearly as profitable to make porcelain as it was to mine gold. It's no wonder then that the Chinese mandarins took great precautions to prevent any foreigner from crossing the threshold of their porcelain works. Potters of many countries tried to find out the secret of porcelain, but they were unsuccessful. About two hundred years ago a Russian craftsman named Dmitry Vinogradov decided to search for the secret.

A short time before that, the Russian government had invited a German potter named Gunger to come and make porcelain for them, as he had sworn he knew the secret. Gunger was given thousands of pounds of clay; he spent an enormous amount of time and money and kept building and re-building kilns, until he finally confessed that he did not know how to make porcelain. He was sent back to Germany in disgrace. Then his Russian helper, Vinogradov, decided to try his hand. He didn't boast of knowing a secret he didn't know, but he was a scholar

and knew how to work on a problem until he had mastered it. Mikhail Lomonosov, the physicist, chemist, geologist, and poet, was a class-mate and close friend of his, and he alone possessed more knowledge than a whole university. Lomonosov respected and valued his old friend, but the tsarist officials ridiculed Vinogradov. They could not accept the fact that he was a proud and courageous man.

After many experiments Vinogradov did discover the secret of porcelain. The tsar's ministers received princely gifts for this discovery, but instead of being grateful to Vinogradov, they chained him to a table and ordered him to write down everything he knew and had discovered. Many years have passed since then, and nowadays the fate of Vinogradov seems like a fantastic fairy-tale.

Scientists and workers alike are respected and honoured by everyone in the Soviet Union. Tremendous quantities of every kind of chinaware, from a little coffee cup to huge vases eight feet tall, are made in Soviet porcelain works. Soviet workers made a great vase to commemorate the second anniversary of Victory Day. They named this magnificently designed vase "Victory." Do you know where it was made? At the very same Lomonosov Porcelain Works which was founded by Vinogradov many years ago. The modern porcelain works is very different from the little shop where Lomonosov and Vinogradov once worked. Everything there is now done by powerful and skilful machines which make the work easier and increase the output. Machines grind down the raw materials, they mix and strain and shape. Just like the ugly duckling who became a swan, the ugly crock has been shaped through the centuries by many skilled hands and minds, and become a brilliant, snow-white swan: clay has been transformed into porcelain.

How many of us have fallen asleep in a train to the song of the wheels! They hit the rails as if they were playing on a steel keyboard, and there is something soothing and lulling in this even rumbling, as if the wheels were saying:

"Good night. Sleep well. Tomorrow you will reach your journey's end. If it were not for us wheels you would have to trudge along the roads with a pack on your back. In summer you'd be covered with dust and soaked by sudden thunder-showers. In winter the blizzards would blind you and hide the road from sight. But we are at your service. We rumble along so that your feet won't have to do all that walking. Sleep soundly. We'll carry you across fields and plains, we'll clatter across bridges over rivers, we'll race through mountain tunnels. And when your friends come to meet you at the station, we'll deliver you to them on time."

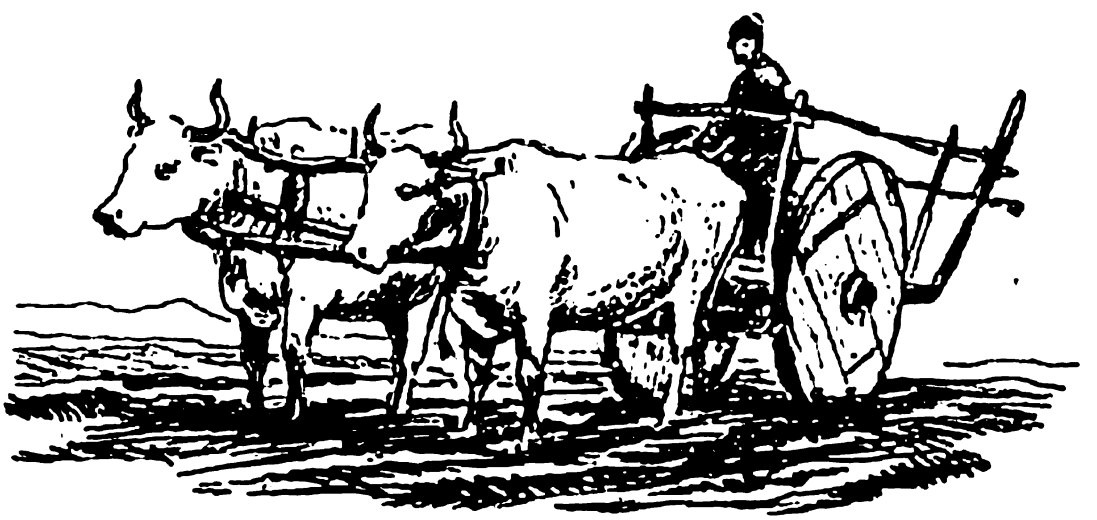
A wheel is a simple thing. We are so used to seeing wheels that it's hard for us to imagine that there ever was a time long, long ago when there were no wheels. But there was such a time. There was a time when people were happy if they were able to travel from one city to another on horseback instead of on foot. For if they rode on a horse they could take more things with them, especially if they had a second horse following beside. This horse was led on a bridle and was called a pack-horse, because all the baggage was put in packs and slung over its back. If a father took his son along, the lad would sit behind his father and hang on to his father's belt for dear life.

How did people finally think of making wheels and carts? Carts didn't appear suddenly. It might seem that the most important part of a cart was the wheels, and yet that's not where the story began. If the shafts and the shaft-bows, the wheels and the runners decided to argue

about who was the oldest, there is no doubt that the shafts would win the argument. The very first cart was made of nothing but two shafts. Two long poles were strapped to the horse's harness. When the horse walked forward the poles dragged along the ground behind. There were cross-bars attached to the poles, and the sacks and bags were tied on to these cross-bars. This is how the grain was carried off the fields in olden times. To this day Canadian Indians use such shafts for carrying loads, harnessing a horse or a work-dog to them.

About two hundred years ago an explorer named Lepyokhin travelled a great deal over the Northern regions of Russia and wrote that the Komi people "do not know anything about waggons, and when they have to transport heavy loads they use a sleigh or two stakes which are tied together; cross-pieces are attached to them and the heavy objects are tied on the cross-pieces."

In the beginning, such a two-poled cart had straight shafts. They were inconvenient, because they got caught in every bump of earth. People started to turn up the ends of the shafts, gradually changing them into runners. From then on it was only a matter of time before the first sleigh was made. A sleigh sped smoothly across the snow, but it was practically impossible to drag it across the grass and sand in summertime, and so



two powerful oxen had to be harnessed into it. Even then it was hard for them to pull it, although the ox is known for its strength, and the old saying goes: "As strong as an ox."

We don't always have to dig in the earth to find such ancient remains, for some of them are still in use today. They say that on Madeira Island, not far from the coast of Africa, you can still see the peasants riding on sleighs in the summertime. The sun beats down all day long, and no one has ever seen any snow there, but the peasants calmly ride along, paying no attention whatsoever to the poor oxen that are struggling under the burden of the heavy, creaking sleigh.

When did the cart finally get its wheels?

In ancient times people realized that it was much easier to roll something than to drag it. A log or a barrel would roll downhill by itself if it was given a little push to start it off. When a large stone had to be moved on a building site, people used to put a log underneath it as a roller. The rock would have never budged without such a roller, but once the log was under it, it would become obedient. As soon as it was pushed or pulled over the roller by a rope it would slowly stir and move as if it were alive. The first wheels probably evolved from such a roller. This transformation did not take place overnight, nor even in the space of a year. It took many centuries.

If a cart were simply placed on rollers even a pair of strong oxen would have a difficult time trying to pull it. To make the rollers lighter, each one was made thinner towards the centre and wider at the ends. And so a log was changed into two thick solid circles set tightly on an axis. The cart with two dragging poles became a cumbersome, canopied bullock-cart with two big circles for wheels.

That's when the wheels first began their song, and what a dreary, whining song it was! When oxen pulled a cart like this along the road, the groaning and squeaking of its wheels could be heard from a long way off. The first bullock-carts had only two wheels, but people soon

realized that four would be much better. And so, in those far-away times, the cart finally got all its four wheels.

Scientists found a covered wooden cart on four wheels while digging in a tall burial-mound in the steppes. The wheels were heavy and made of solid wood; the top looked like a little wooden hut with a rounded roof and front entrance. When the nomads of the steppes moved from pasture to pasture these clumsy carts crawled along behind the herds, squeaking on their heavy wheels. The men and the boys over seven years of age herded the sheep on horseback. The women and small children rode behind in their travelling houses.

That's how the waggon got its wheels. Can you imagine how many changes these wheels had to undergo before they became wheels as we know them today!

First of all they had to be made more durable, to prevent them from wearing out quickly on long trips. This was done by putting a copper band over the rim of the wheel, and nailing it firm with copper nails. From this alone we can judge how very long ago this was, for iron had not then been discovered. When the copper band was nailed round the wheel, it made it very heavy, so holes were cut in the solid wood circle to make it lighter. Later, the wheel was made to rotate freely on an axis. And finally, after many changes, the wheel became what it is today, a wheel with spokes, a rim, and a hub attached to the axis.

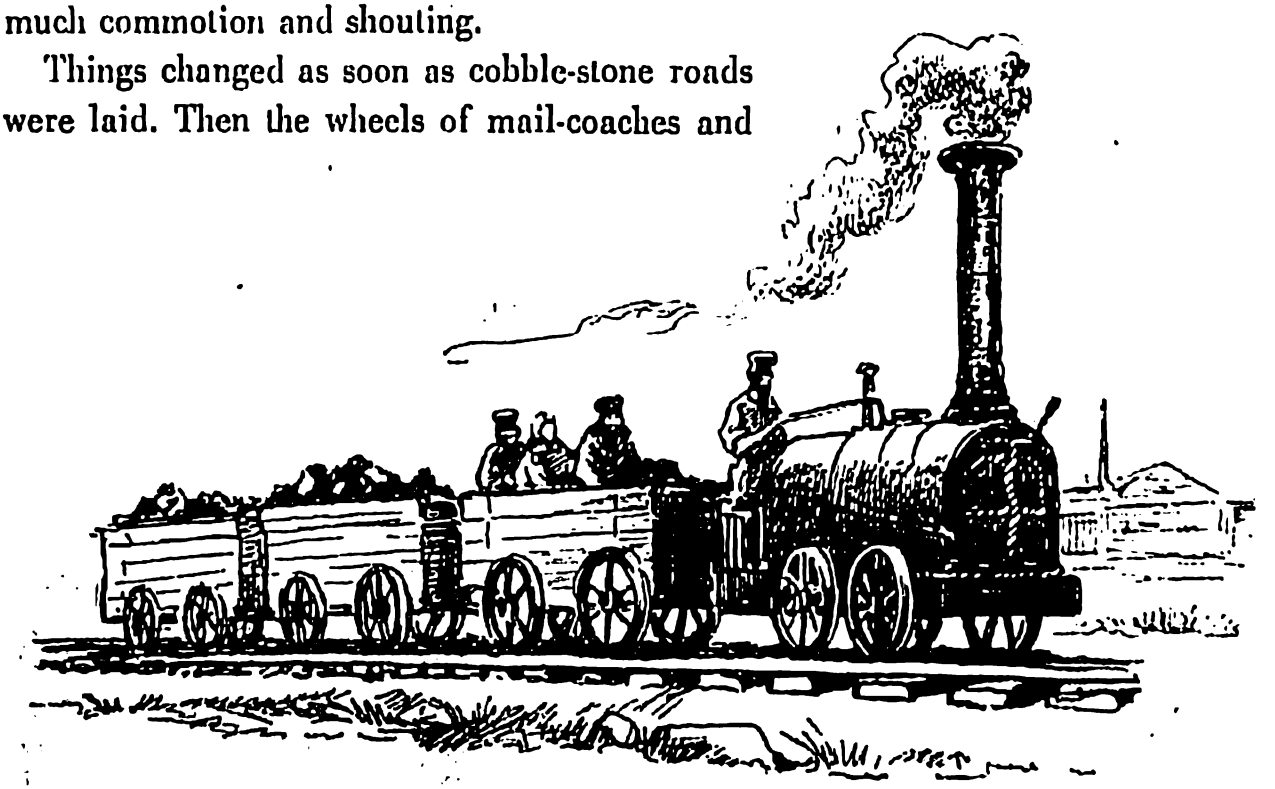
However, even in its modern form, the wheel did not at once become popular. For a long time people preferred to ride on horseback, transporting their heavy loads by pack-horse. Why? Because the wheels had their own contrary ways. They were very tiresome, and if they were not oiled they would start screeching and whining. Mainly, though, they resented it if they got stuck in the mud or in sandy bogs and insisted on smooth, even roads without any bumps or pit-holes. But in olden times there were no such things as good roads. Highways were not laid down as they are today. A road was just beaten earth, a track that

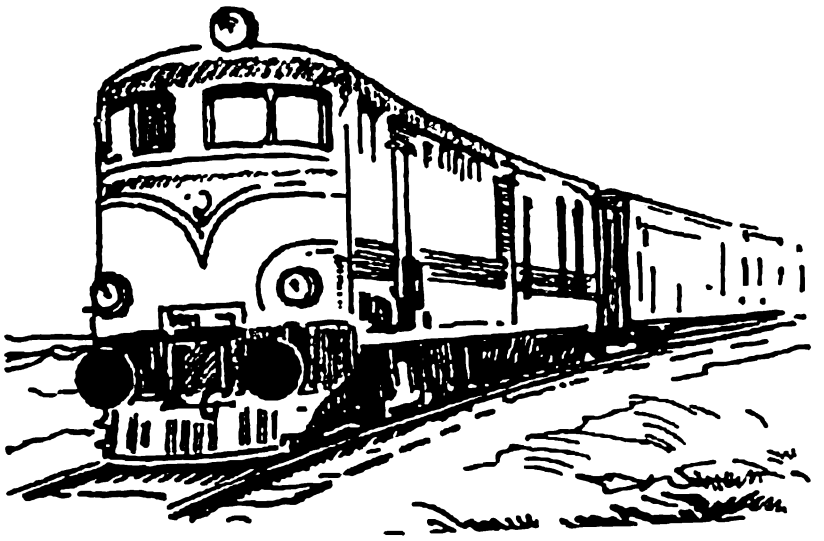
gradually got traced out by the many riders and foot travellers that followed a certain way.

As time went on, people began to pay more attention to their roads. They cut paths through the forests and laid log causeways over the swamps to prevent the vehicles from getting bogged down. Nevertheless, a long time passed before roads became as smooth as the wheels wanted them to be. Not more than two hundred years ago travellers were still complaining of the roads and of the way their carriages always broke down.

In those days, if a rich landowner set out for Moscow from his country estate he had six horses harnessed to his carriage. Men on horseback rode in front and behind, leading spare horses. The landowner did not make all these preparations merely for the sake of showing off, but as a precautionary measure, in case the road turned out to be muddy and the carriage got bogged down. If this happened, a dozen spare horses were harnessed to the carriage. His servants would lean on the wheels and pull the heavy coach out of the mud with much commotion and shouting.

Things changed as soon as cobble-stone roads were laid. Then the wheels of mail-coaches and





carriages started speeding down the paved highways, flashing by the striped milestones and the avenues of birch-trees. The wheels had made friends with the roads, but this friendship became even closer when the railroads were built.

In the Ural Mountains there's a city called Nizhni Tagil which has a street with a very strange name. It's called Boat Street. Why? Boats don't travel on land! But it got its name because at one time "land-boats" really did travel along that street. The "land-boats" of long ago were the steam-engines of today.

These were very small, clumsy, four-wheeled steam-engines with a smoke-stack as long as a giraffe's neck. But they clattered along the rails, pulling a load of three and a half tons or forty passengers in the carriages behind them.

You would never have imagined that the little steam-engine was the direct descendant of the ancient cart of two shafts. The shafts of the ancient cart came into use long before wheels, and when the cart finally became a steam-engine, there was no longer any use for the shafts, as there was no longer any need for a horse. The wheels were then elevated to the place of honour. A smoother road than they had ever seen before was built specially for them. The Tagil railway, laid by two Russian workers, Yefim Cherepanov and his son Mikhail, was only half a mile long. It wasn't very impressive, but it was the first Russian railway.

There are over 62,100 miles of railway tracks in the Soviet Union today. They branch out from Moscow in every direction, north, south,

east, and west, reaching to the very farthest cities. The huge steam-engines with their heavy cargoes are not the only trains to thunder down the tracks—there are also their younger friends and rivals, the electric and diesel trains.

The iron wheels speed along the smooth steel roads. And as they go, they sing their happy song, lulling the drowsy passengers to sleep.

CONVERSATION IN A CARPENTER'S SHOP

You have now read a lot of stories in this book, but you haven't yet found a single fairy-tale. So we have decided to tell you a fairy-tale. It's not about a wondrous fire-bird or a dragon. It's about everyday things: about a saw, an axe, and a plane. Listen to their story.

One day, there was a great commotion in the carpenter's shop. The saws were buzzing, the files were screeching, the axes were chopping, and the hammers were pounding. The instruments were interrupting one another and trying to drown each other's voices. Each one wanted to prove that he was the most important one in the shop.

"I chew, and chew, and chew everything to bits!" sang the saw, as it worked away at a board, spitting sawdust at each word. "I have a hundred teeth, each one as sharp as a knife."

"Chop! Chop!" chortled the axe. "Watch out! I can split the thickest pole with a single blow!"

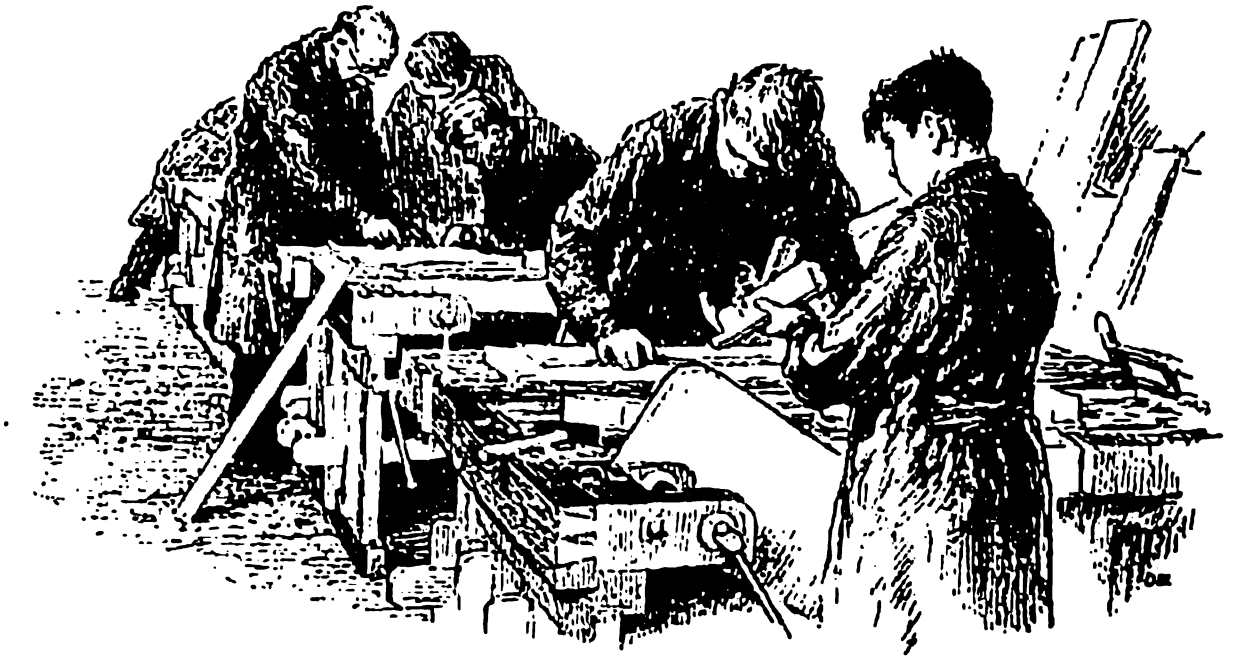
The plane swished back and forth along a board, and it threw out curly shavings at each swing. It hissed at the axe, "Well, well, what an empty boaster you are! You can only do the crudest work. When a thing is made crudely they even say, 'It's done with an axe.' You're a

carpenter, not a joiner. They don't even let you near a joiner's bench. Now you take a plane.... I plane a board so well that it becomes as smooth as silk."

The saw answered, "You've nothing to shout about, for you'd have no work at all if we saws had not cut down the trees in the forest. You can't build a house, much less a table, without a saw. *I* am the most valuable instrument in the shop. That's why the master is so proud of me and takes special care of me. The first thing he did when he bought me was to take a saw-setting pliers and set my teeth, one to the left, one to the right, left, right, left, right, and so on. He did all this to make it easier for me to do my work. When a saw's teeth are set, it saws a wide path in the wood, it slides back and forth easily."

"Bang! Bang!" pounded the hammer, interrupting the saw's long speech. "I bang the loudest and can drown out all the rest of you. That means *I*'m the boss here. Of course, there are all kinds of hammers. Take my two brothers, for instance. One is called Mallet, and the other Sledge-Hammer. They are part of my family, but their characters are quite different. One is soft and the other is hard. Brother Mallet is made of wood and you can only use it on a chisel. Brother Sledge-Hammer is made of steel and a carpenter's shop is no place for him, he works in a smithy. When the smith's striker brings him down on a piece of red-hot iron, he makes the iron as flat as a pancake."

"We are quite a big family ourselves," said the saw. "There are all kinds of saws too, you know. For instance, they call me Cross-Cut Saw because I saw wood across the grain. I have a brother called Rip-Saw, and he's really an expert at sawing wood along the grain. We're twins, identical in every way except for our teeth. The baby of our family is called Fret-Saw, and all he can do is to saw plywood. There are huge saws which make boards out of logs. If you have ever been to a sawmill you have seen the big logs go in at one end of the band-sawing machine and boards come out at the other end."



"My family is still bigger," boasted the plane. "I have so many brothers that I quite lose count of them. One is called Smoothing Plane, another Double Plane, a third Plough-Plane, a fourth Jack-Plane. . . ."

"Stop!" boomed the axe. "We're not impressed by all those names—Jack-Plane, Smack-Plane. My name is just plain Axe, and I do simple work, but I do it well. If something has to be rough-hewed or split, they always turn to me, the axe!"

"He's so rude!" said the plane. "Always interrupting. To continue, I have very many brothers and each one has a job of his own. The smoothing plane planes long boards and that's why he's a long fellow himself. The compass-plane is an old hand at getting rid of bumps and dents. The plough-plane goes along the ledges and furrows into places an ordinary plane cannot reach, however hard he tries. The jack-pl—"

"What a bore!" the file interrupted. "Of course, both a plane and a saw are useful workers, but we files are much more useful. We start on a job where the rest of you leave off. *I* bring beauty to the work, for I smooth out all the rough spots you have left, and finish the job nicely!"

"Look at the artist, just look at him!" snarled the saw. Then it suddenly stopped talking and sawing. After a moment or two it said, "My teeth seem awfully blunt. This is really a tough piece of wood I have

here. It's easy to saw deal-boards, but oak is something else again. Oak is so hard that it will blunt the sharpest saw's teeth. Do sharpen my teeth a bit, File!"

"You see, a file's got its uses!" said the file, and started to sharpen the saw's teeth.

One-two, one-two, it went, along the whole row of teeth.

"See? The saw would never be able to saw without me!" it said.

The saw was just thinking up a caustic answer when the carpenter laid it down and picked up the chisel. The chisel was overjoyed.

"Look out, you chaps! It's my turn now! None of you know how to chisel, but just watch me!"

"You won't get far without me," warned the hammer, which the carpenter had taken up with his right hand. "Well, get a move on, now!" And with these words, the hammer began to strike the handle of the chisel.

"Help, help!" screamed the chisel. "Don't hit so hard, you'll split my handle!"

"You don't say? You're so lazy that you won't work at all if I don't hit you hard enough. You can't even bite into the wood by yourself. And you nails there, why are you twiddling your thumbs? Fall into line!" The hammer started driving the nails into a board with all its might. No one heard what the nails had to say about it, for the hammer was making such a racket. Suddenly, one of the nails bent in half. The hammer stopped in mid air, and the nails took advantage of this pause to voice their protest.

"This is terrible!" they shouted. "It's against the rules! You have to hit us straight, not sideways!"

"Keep calm, it can all be fixed," the hammer told them. "I banged you in and I can pull you out again." So saying, it turned its curved, forked ears to the nail, grabbed it by its head and yanked it out in a

second. In two blows it had straightened the bent nail and banged it into the board again.

"*I*'m the most important one! *I*'m the most important one!" the hammer gloated as it drove the nails into the board.

Suddenly a dignified elderly voice said, "Don't be so sure of yourself. You're making too much noise." The voice belonged to the old carpenter's eye-glasses. Perched on his nose, they waited for a quiet moment to join the conversation, and spoke out when the old carpenter had paused to lay down the hammer.

"Why are you quarrelling?" the eye-glasses went on. "You're all members of the same family, you know. You never read books and have no learning at all, but the master and I have read a great many books, big ones and little ones. We've even read a book about all of you. It said that you are all descended from stone."

"What do you mean, from stone?" the axe was quite peeved. "I'm made of shiny steel and my handle is made of the stoutest wood."

"Don't get so uppish," answered the eye-glasses. "You're made of steel, but your great-great-great-great-great-grandfather was made of stone. Many years ago no one had even heard of steel and iron. Instead of chopping things with axes, craftsmen used sharp stones. Later, they started tying handles on to the stones to make them more manageable. Hammers used to be made of stone, and saws—"

"I don't believe you!" the saw screeched in a very offended voice. "No one can saw with a stone."

"And why not? Not with a plain stone, of course, but with a jagged-edged one. People had to work on a stone for many days to make its edge sharp and jagged. It wasn't much of a saw, but still, it sawed."

"If that's the case, then *I*'m the most important one here," said the whetstone. "I'm the eldest, I'm the first worker! I was made of stone and I still am." And the whetstone spun around faster and faster, sharpening the axe and giving off a spray of bright blue sparks.

"You're neither the most important nor the first," grumbled the eye-glasses. "When my master came to work this morning he pulled us out of his pocket, rubbed us clean and set us on his nose. And so the two of us had a look at the honour-roll. You might think it's just a bulletin-board, but it's a very special one, for it has the name of the best worker in the shop written on it."

"Well, that means *my* name is on it," said the saw, "for *I* was the one who sawed the wood for the bulletin-board."

"No, it's *my* name that's on the board," said the plane, "for *I* was the one who planed the wood."

"No," said the hammer. "It was *I* who drove in the nail that holds the board on the wall."

"You're all wrong," said the eye-glasses. "There's a name there, but it's not the name of an instrument, it's the name of a person. We don't really amount to much without a person. People invented us, people made us, and people use us. Vasily Petrov is the name on the honour-roll, and he's the best worker in the shop. He's the master's pupil. Before, everyone used to call him Vasya for short, because he was so young. But they call him respectfully Vasily now. He produces more in one day than anyone else does in three days, and all because he's so industrious."

Then all the instruments started talking at once: "We know him well. He takes good care of us and always puts us away when he's finished a job. He sharpens us and repairs us on time, and we repay him in kind. In his hands the saw cuts through a board as if it were made of butter, and the plane flies back and forth as if it had wings."

"The master can't praise him enough," said the eye-glasses. "As soon as he saw Vasya's name on the honour-roll he said, 'Goodness me, he beat his teacher! He's not yet twenty and he's the best worker in the whole shop!'"

THE OLD WORKER'S SECRET

There was a time when every skilled worker hid the secrets of his trade from those around him. If he had to write down the composition of some alloy, or the various ingredients used to make porcelain, he'd never write "gold," "silver," or "clay." In place of these words which anyone could understand, he'd write words which only the few people in the know could understand. He wrote "sun" instead of "gold" and "moon" instead of "silver." He wrote words like "sand," "sulphur," and "salt" in the most mysterious way; he didn't even use the words of his own language, but those of long-forgotten ancient tongues. Aside from such complicated words there were also many complicated symbols in the craftsman's recipes. The symbol for water was an upside-down triangle and that for fire was a right-side-up triangle. "Salt" was a circle with a line through it; "gold" a circle with a dot in the centre; "silver" was a crescent, and "copper" a cross in a circle. Sometimes the shrewd craftsman invented words and symbols whose meaning was clear to him alone.

About three hundred years ago an old Italian craftsman discovered a new way of making stained glass. He was renowned for his beautiful goblets and vases, and his fame spread far beyond the borders of his native land. People marvelled at the green glass leaves and bright glass flowers intertwined round the stem of a vase or the handle of a goblet. Try as they might, the other craftsmen were never able to make such lovely glass as he did. They used fair methods and foul to make the old man part with his secret, but he was a shrewd old fox and they never got it out of him. The old man had a son who was also getting on in years, but he never even told the secret to his own son, fearing lest it should get around. The son helped in the workshop, but whenever the old craftsman had to prepare the mixture for his beautiful glass, he would lock

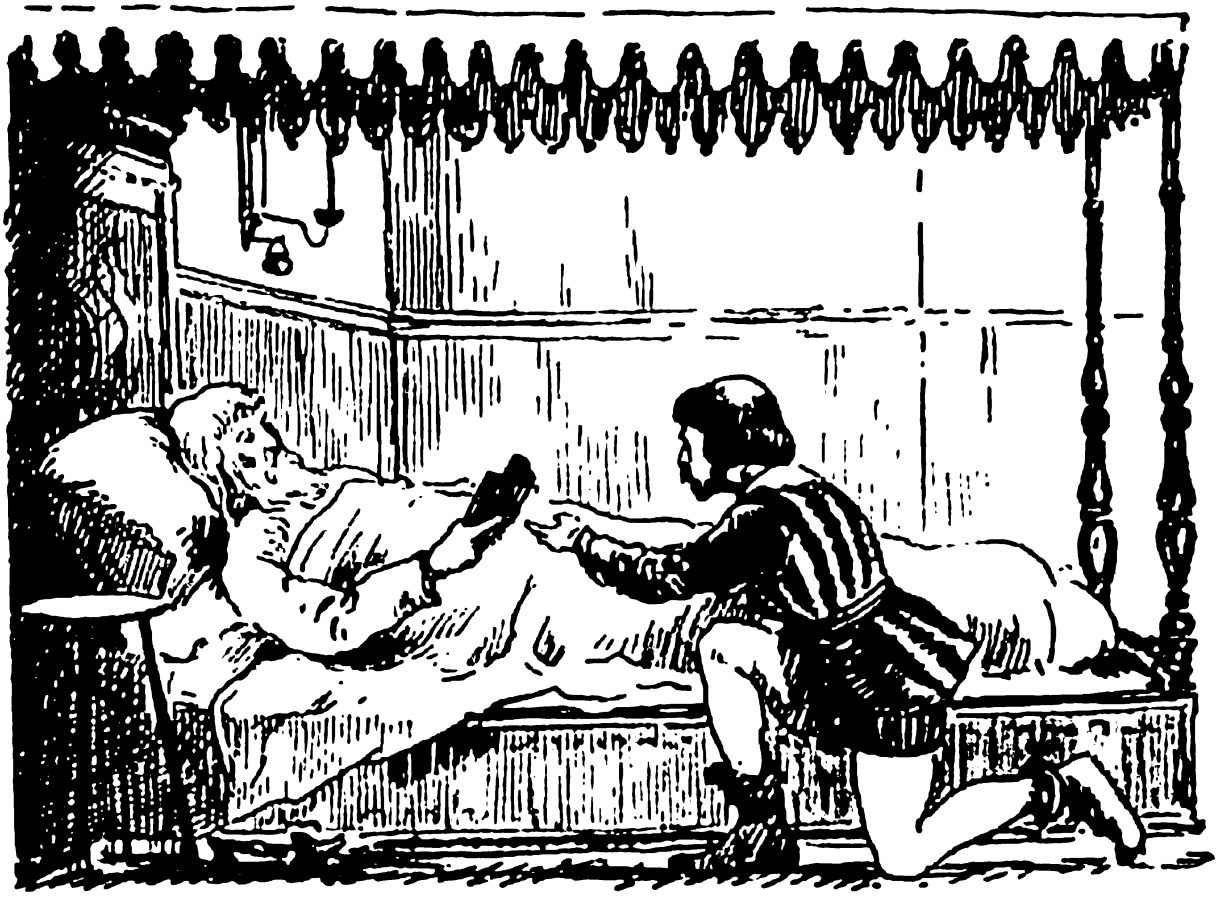
himself in a room and refuse to let his son in. "Wait," he would say, "there's no hurry. You will not have to wait much longer. I'll tell you all my secrets before I die and you'll be rich and famous too. You'll get a small inheritance, but your main treasure is this little book. With this, you can do everything you want." And the old man showed his son a little brown leather book. All the pages were filled with strange symbols, and the old man was the only one who knew their meaning. He himself kept changing the meanings and thinking up new symbols, so that the writing became more and more complicated and mysterious as time went on.

The son often asked his father to explain the meaning of the symbols, but each time his father answered, "Wait a while, there's no hurry." Then, one day, the old man became very ill. The son thought that it was high time he told him his secret, but the old man kept repeating stubbornly, "I'll be up and around again soon." His illness was very serious, however, and the day finally came when he realized that he would never get up again. He called his son to his bedside and told him to fetch his little brown book. He then started leafing through the pages.

"Listen carefully," the old man said, "and I'll tell you everything." Suddenly, the most unexpected thing happened. Perhaps his memory failed him, or his eyes, but in any case, he could no longer remember the meaning of his own symbols and the strange invented words which were so difficult to pronounce. For long they had been a mystery to everyone else, and now they were a mystery to him too.

"Wait, don't be in a hurry," the old man mumbled, repeating the words he had said so many times before. But this time his voice shook and he tried not to look at his son, who was standing impatiently at his bedside, waiting to be told the great secret. The old man kept turning the pages, whispering something to himself, shaking his head and frowning. It was no use. He couldn't make head or tail of what he had written.

"Wait a while. I'll rest for a few moments, and then I'll tell you



everything." The old man closed his eyes and never opened them again. The son was so stunned and depressed that he quickly spent his entire inheritance, everything his father had saved in a lifetime. Soon all he had left was the brown leather note-book. He would have gladly sold that too, but it would not have fetched a penny, for who would be foolish enough to buy a book they couldn't read!

All this happened long ago, but there are still some people living today who remember how the craftsmen of days gone by made a mystery of the secret of their skill.

An old steel founder in a Moscow factory was once asked to tell the young people how he had learned to found steel. This is the story he told them.

Many years ago he had been apprenticed to an experienced, skilled steel founder, famous for many miles around. They said that he also

had a secret, which he never told to anyone. He used to put on a pair of blue eye-glasses and peer through the little window of the furnace, but what he saw there remained his secret. He would look into the furnace intently and immediately know what had to be done. "Add some lime," he would say to his apprentice. But he never explained *why* lime had to be added, and used to get very angry when anyone asked him about it. His apprentice stopped asking questions and decided to find out the old man's secret for himself. At first he thought the secret lay in the strange blue eye-glasses which the founder never parted with. And so, one day, when his master had gone away, leaving his glasses on the table, the apprentice popped them on his nose and went over to the mysterious window. He had looked through it many times before, but it was as difficult to look through the furnace window as it was to look straight at the sun. The hot, bright flame blinded him and made his eyes smart, and the old man would laugh at him and say, "Curiosity killed the cat."

But when he looked through the blue glasses his eyes were shielded from the unbearable heat and glare, and the apprentice was able to see what was going on inside the furnace. Liquid cast-iron was bubbling in a white flame. White-hot pieces of scrap iron were melting in the cast-iron. The blue glasses made it easy to see exactly what was happening inside the furnace, but they still didn't explain *how* to found steel.

Just then, the master returned. The apprentice was so intrigued by all the wonderful things he could see, that he did not hear the old man come in until he was standing right over him. "Well, well," the old founder said. "You're just like the monkey in Krylov's fable, and you're no smarter from wearing glasses, either."

But the apprentice did not give up. He was determined to discover the secret. He had often seen the old man writing in a little book.

"If I could only lay my hands on that book!" the apprentice thought to himself. "I'm sure everything's written in it: how much of what to

put in the furnace and how to found the steel." Then, one day, the old man dropped his mysterious book. The apprentice picked it up and excitedly began to turn the pages. "Now the secret's mine," he thought. But he was wrong. The pages of the little book were filled with numbers and strange symbols. Try as he would, the apprentice could not understand a thing. The old man must have set great store by his secret, for instead of letters, he purposely used symbols which he alone could understand. The apprentice was a stubborn lad and he began to watch everything the founder did even more closely. The old man would take an assay from the furnace and look at it to see whether or not the steel was ready. He would be able to tell whether anything had to be added or whether the steel was ready for cooling just by looking at the piece of steel. His apprentice used to collect the discarded assays and take them home. In his spare time he examined them and tried to understand in what way they differed from each other.

Many years went by. The apprentice himself became a steel founder and a very skilled one, at that. Everyone in the steel mill knew that Nikolai Ivanovich could found steel faster and better than any of his younger fellow-workers.

One day the steel founders got together to see what could be done to speed up the process of founding steel, and a young worker said, "Let's ask Nikolai Ivanovich. I'm sure he knows some secret because the furnace always obeys him."

"I don't know any secret," Nikolai Ivanovich said, "but I have knowledge and experience. In the old days the skilled founders kept everything a secret. Do you know why? Because if they told all they knew, then the other workers would have become as skilled as they themselves were, and they would have lost their renown as well as their higher wages. They might even have lost their jobs!

"Nowadays, in Soviet factories, skilled workers are all the more honoured if they work well themselves and teach others their trade.

I had to learn everything the hard way, but with you youngsters it's different. If you want to learn from me you can, because I am ready to share my knowledge with you."

The old founder was not an exception, for all the workers share their knowledge and experience with each other.

Here is a story about a factory where machines are made.

Two young women worked there. One was called Nadya and the other Sveta. They were childhood friends, had gone through technical school together, and had come to the factory as turners, where they worked side by side on two lathes. One day Nadya said to her friend:

"Everyone here at the factory is competing with each other. Let's compete too, and see who can finish more parts in a day."

And so they started working faster, trying not to waste time. Nadya was ahead from the very first day; her hands were quick and sure. No matter how hard Sveta tried, she couldn't catch up with her friend. She stayed up all night thinking of ways to overtake Nadya, and the next day she came to work earlier than anyone else. She polished her lathe and put all the instruments in perfect order on the shelf before her; she didn't look at Nadya as she worked, so as not to be distracted. While the lathe turned one part, Sveta got the others ready. She felt pleased, and the lathe turned faster. In the evening they added up the parts they had each turned during the day. Even though Sveta had worked hard and well, Nadya was still ahead. Sveta had fulfilled one norm and Nadya one and a half. A norm is

the amount of work each worker is expected to do in a day. Sveta was very unhappy. Then an old skilled worker came over to her and asked:

"Why are you so miserable? Is it because you're so far behind your friend? Then why don't you ask her to show you how she does so much?"

"Why should she want to teach me? Don't you know we're competing?"

The old turner said, "I think you're being foolish. You both have the same interests at heart and the more workers we have like Nadya, the sooner our factory will rank among the best, and the more machinery we'll give the country."

Sveta took his advice and went over to her friend after work and said, "Nadya, tell me how you manage to do so much in a day."

"I'm so glad you asked me," Nadya answered. "I was all ready to tell you myself. Let's stay on after work today and I'll show you everything."

After that, the workers in the shop saw that Sveta was getting more and more done with each passing day. Her lathe was turning at top speed, and the metal shavings just flew off from under her cutting tool. Sveta caught up with Nadya and then left her behind, as she fulfilled two norms in a day. It was then that Nadya said, "Now it's your turn to teach me, Sveta. I think you've thought of something new and I can't keep up with you any more."

From that day on they started catching up with each other and helping each other. If you talk to the workers in Soviet factories they can tell you of many such incidents. Everyone in our country tries to help his fellow-workers and doesn't have to keep his experience and knowledge to himself, for everyone is working towards the same goal.

THE WONDERFUL STOREHOUSE

THE WONDERFUL STOREHOUSE

There's a wonderful storehouse on our planet. If you put a sack of grain into it in the spring, twenty sacks will have sprung up there by the autumn. One pail of potatoes will become twenty pails. A handful of seeds will turn into a huge pile of cucumbers, radishes, tomatoes, or carrots.

Have you ever seen a seed with two little wings? The kind that will fly away if you blow on it? If one of these winged seeds sails into the storehouse and stays there a while, a huge shaded tree will sprout out from the spot where the little seed fell.

Is this going to be a fairy-tale? No, it's not a fairy-tale. The wonderful storehouse really exists, and you've probably already guessed what it's called. It's called the earth. You may be sitting at the table and reading this book. Both the table and the book were made from a tree, and the tree grew from a little seed which fell into the earth. Your shirt is made of linen, and the linen came from flax, and the flax grew from a seed planted in the earth.

In springtime the storehouse is unlocked: the field is ploughed up with a sharp-edged plough. Then the seeds are put into it: that is, the grain is sown in the field. After this the storehouse is locked up again: the grain is covered over with earth. Potatoes and seedlings are also put into the storehouse. In autumn the master comes to collect what the wonderful storehouse has put away for him. There are mounds of grain, potatoes, carrots, cucumbers, and cabbage.

The wonderful storehouse will only obey a good master. It will never treasure things for a lazy one. A lazy master gets weeds instead of grain, carrots, cabbages, or other vegetables. Where do these weeds come from? When it was time for planting, the lazy master did not bother to sort out his seeds. He sowed the good grain and the weeds all together, and of course the weeds were very pleased at being planted just as if they were real wheat or rye, and started growing by leaps and bounds. They choked the shoots of grain, robbing them of water and sunlight. They were growing wild in the garden, too. The vegetable beds ought to have been weeded, but the lazy master didn't feel like bothering. That's why, later on, he found nothing but weeds there, too.

The industrious master took good care of his property and tended it all the time. He set aside the best seeds for sowing, he fertilized the earth, he ploughed deeply, and harvested his crop just when it was ripe.

without losing a single grain. The good master never allowed the weeds to grow in his field or in his vegetable garden. He waged an endless war against them, as if they were his worst enemies. That's why the wonderful storehouse gave the good master so much and the lazy master so little.

And this means that even the most marvellous storehouse can not work wonders unless you play your part. If you work well together with your neighbours, you won't have to wait long for the wonders.

Long ago, before the October Revolution, the peasant had a hard life. He had very little land, because the landlords owned most of it. He didn't even have enough money to buy a plough, let alone a seed-drill or a reaping-machine. He wouldn't know what to do with such machines even if he had them, for there was hardly room for a horse and plough to turn round on his little strip of land. The peasant sowed the seeds of weeds and grain all together, because he had no machine to separate the wheat and the rye from the weeds. The landowners and the rich farmers called *kulaks* were the only ones who could afford to buy farm machinery.

Things changed when the land became the property of the state, and the peasants' tiny strips were joined together to make the immense collective-farm fields. The Soviet Government established machine and tractor stations to help the collective farmers in their work.

There are many powerful and efficient machines in these stations. One machine ploughs, another sows, a third reaps, and a fourth threshes by shaking the grain from the stalks. The threshed grain is full of dust, bits of stalk, straw, and dirt, therefore a fifth helper called a winnowing-machine blows the chaff from the grain, sorting it out through sieves. There is another machine that separates grain from the seeds of weeds. When the time has come to plough up the fields, a large tractor-drawn plough arrives from the machine and tractor station; when harvest time comes round the farmers call on the combine-harvester for help. That is

a most efficient worker, for it does many jobs at once: it reaps, and threshes, and winnows, and pours the grain into sacks.

Many interesting machines have been invented. Potatoes used to be planted by hand, but now engineers have invented a potato-planting machine. As this machine moves along the field it makes a furrow, picks a potato out of a box, drops it into the furrow and covers it over with earth. A machine that plants seedlings has been invented too. In one movement it sets six little plants into a furrow and immediately waters all six of them; then it takes a step and plants six more. What a fine nurse it is to take care of six babies at once!

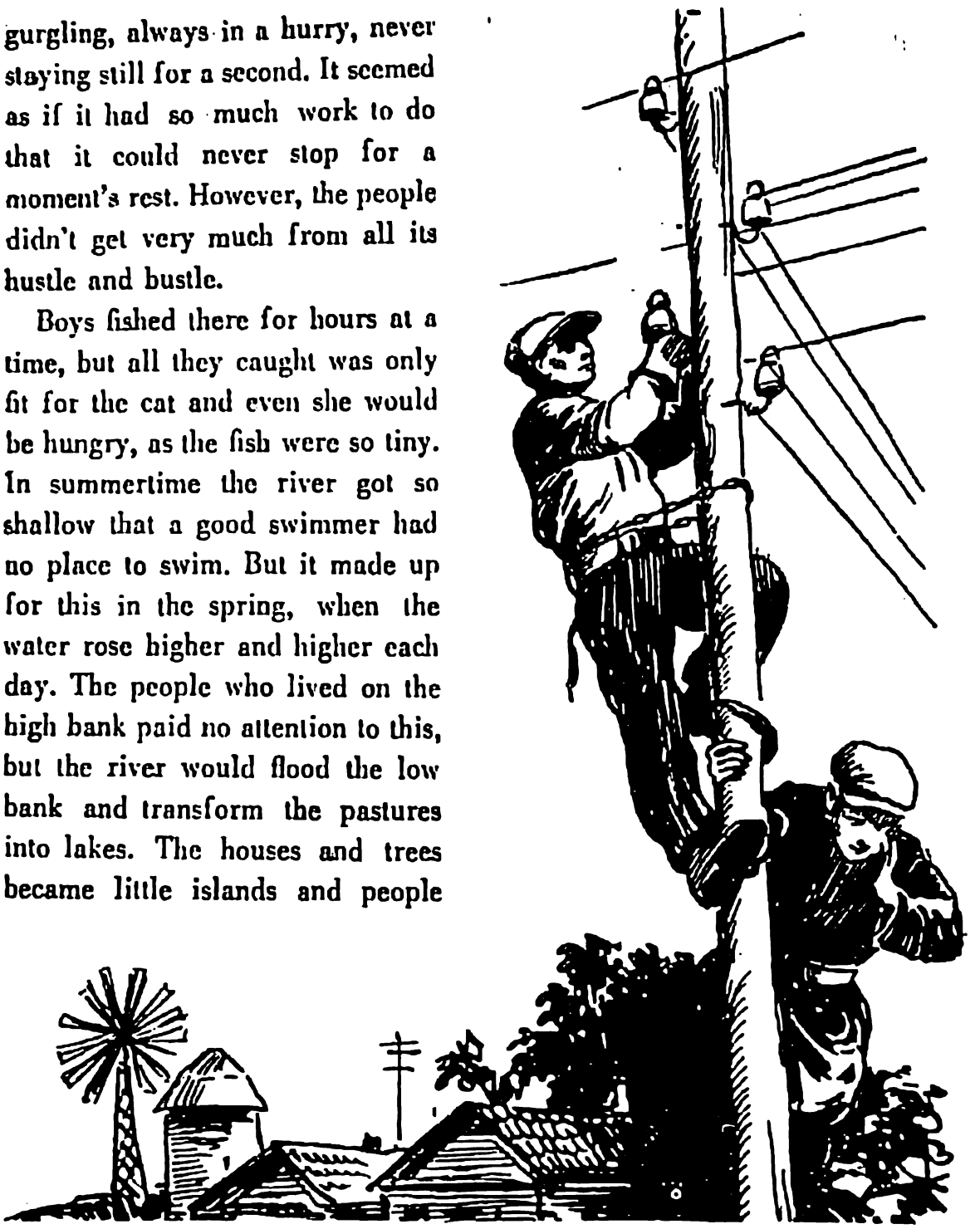
Factory workers have built many new and useful machines, and with each passing year these machines have made the farmers' work easier. In the old days a peasant never knew whether the land would support him or not, whether he'd have a good crop or a bad one. Nowadays, people don't wait for nature to give them presents, they make her give them everything she's got. The farmers in our country fertilize the land, grow new and better varieties of plants, drain swamps and irrigate deserts. For all their labours the wonderful storehouse called "earth" rewards them with more bountiful crops of grain, apples, pears, vegetables, flax, and cotton.

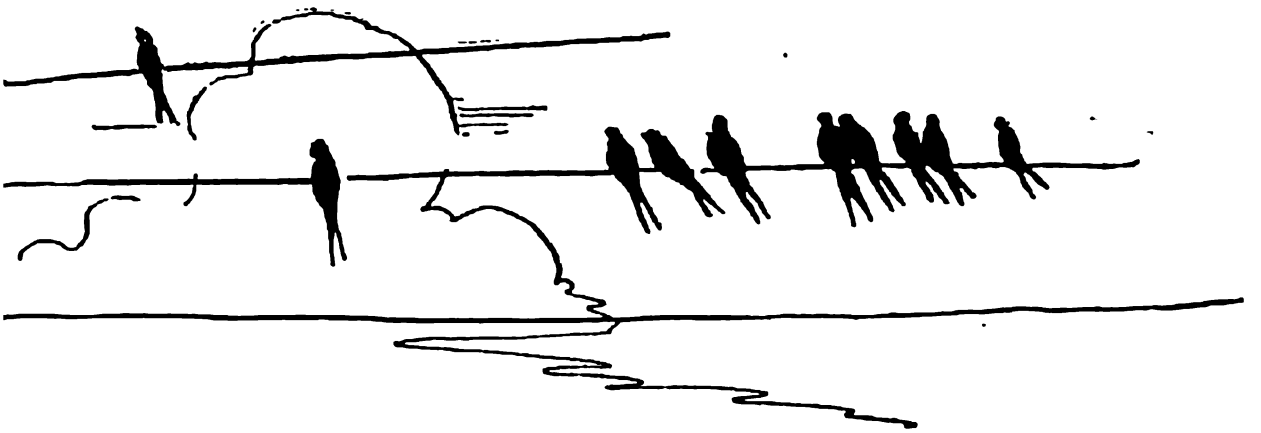
HOW THE COLLECTIVE-FARM RIVER WAS PUT TO WORK

A little river flowed through a village. One of its banks was high and steep and the other was low. There was a row of houses on the steep bank and a row on the low bank. In summertime people waded across the river, and in winter they crossed over the ice. It was joyous and

gurgling, always in a hurry, never staying still for a second. It seemed as if it had so much work to do that it could never stop for a moment's rest. However, the people didn't get very much from all its hustle and bustle.

Boys fished there for hours at a time, but all they caught was only fit for the cat and even she would be hungry, as the fish were so tiny. In summertime the river got so shallow that a good swimmer had no place to swim. But it made up for this in the spring, when the water rose higher and higher each day. The people who lived on the high bank paid no attention to this, but the river would flood the low bank and transform the pastures into lakes. The houses and trees became little islands and people





went visiting in rowing-boats, climbing into their boats right from their front porches.

Everyone on the collective farm had a job to do. The river alone did nothing. The grown-ups all worked. The children went to school, played, helped out with the chores at home, gathered mushrooms and berries in the forest. The horses carried fire-wood, hay, and dung, or anything else that had to be taken from one place to another. The cows gave milk, the sheep gave wool. The apple-trees in the collective-farm orchard gave people piles of large sweet apples every year. The fields and gardens, the pastures and forests all served the people faithfully. Without them the collective farmers would have had neither wheat nor cabbages, oats, nor flax, there would have been no logs for building and no fire-wood. Everyone was busy at his job. The river alone lived its carefree life without taking any notice of anyone. One day, the collective farmers got together and decided to put the river to work. But what could a river do? Why, it could do anything it was told! The main thing was to teach it how to work, then it would be an asset to everyone. A river can help with the housework, it can milk cows on a dairy farm, it can plough land, water cucumbers in the garden, and do many other things besides. Why, it can thresh rye and saw logs, grind grain at the mill and shear lambs, and it can even sing songs and tell stories!

If you take a good look at a river, you'll see right away that it's very strong. In the spring it carries big logs along as easily as if they were

splinters. If you want to swim right across a river you have to fight against its current or else you will be swept downstream. To think that such strength is wasted!

But how can a river be made to work? It must be stopped in its course and told, "First, do what *we* want you to do and then you can go on your way."

But how can a river be caught and stopped?

It must be blocked by a high wall, called a dam.

But what if it breaks through the dam?

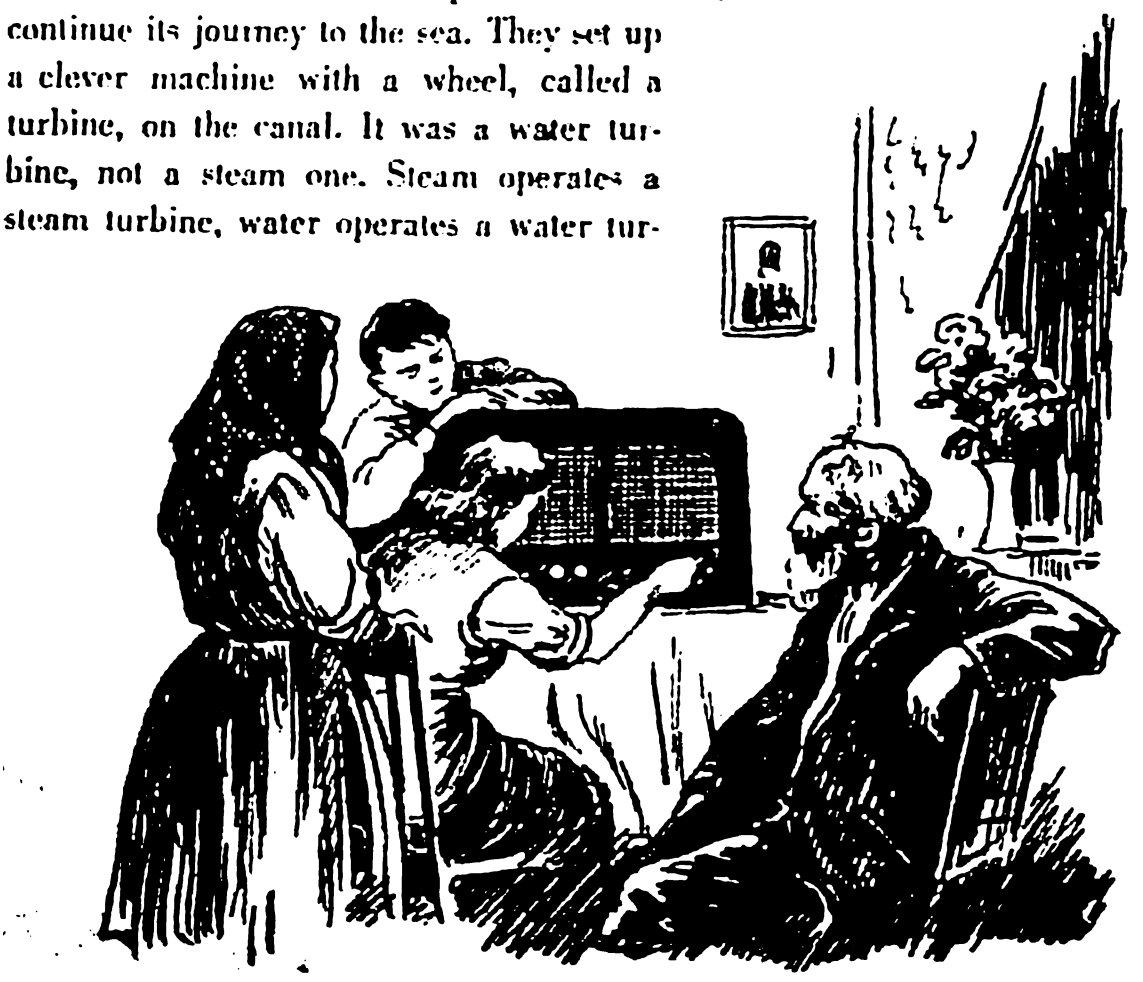
The dam must be made strong enough to withstand the river's current. Two rows of sturdy boarded logs, called piles, are driven in to form two walls. Then the space between the walls is filled in with clay to make everything water-tight, for clay prevents water from seeping through a dam. A dam should never be built without gates. In springtime the sun melts the snow in the fields and forests, causing little rivulets of snow-water to flow into the river. Then the water rises higher than the dam, flows over the top, and can even wash it away. To prevent this from happening, a dam must have sluice gates—locks in the dam through which the water may be let out when necessary. This is exactly what the collective farmers did. They chose a good spot not far from the village and built a dam like this.

As before, rivulets, streams, underground springs and rain-water continued to flow into the river and towards the dam. There its way was blocked, for the gates were closed. The river tried to loosen the piles, but it was unable to do so. They were driven very deep into the river-bed and withstood the pressure of the water. So, the river started looking for cracks between the boards. Alas! The people who had built the dam hadn't left a single crack anywhere! The water began to rise, but it couldn't reach the top of the dam.

Where could it go? Having no escape, it went right over its banks and flooded the surrounding countryside. Before the dam a great pond

was formed, so deep you couldn't touch the bottom. On the other side of the dam the river became very shallow.

This river had led its own life for very many years. It had flooded its banks whenever it felt like it, and then, suddenly one day, people said, "Stop!" and had started telling it what to do. They knew it would be difficult to keep the river captive for long, because the water would keep on rising. And in no time it would flow over the dam and escape towards the sea: then why all the fuss to begin with? The river was trapped, because it had to do some work before it could continue on its way. The people made a little canal leading out of the pond, round the dam, and into the shallow part of the river, where the water could continue its journey to the sea. They set up a clever machine with a wheel, called a turbine, on the canal. It was a water turbine, not a steam one. Steam operates a steam turbine, water operates a water tur-



bine. The water was so pleased that it could find a way forward again that it rushed along its new path and straight into the trap—the turbine wheel! The water plunged down into the trap at full speed and started the wheel spinning.

That's just what the people were waiting for, because they had not brought the turbine over such a long way for nothing. They built a little wooden electric power station around the turbine and installed a generator that produced electric current. The machine would only make electricity if it was spun around very quickly. How could this be done? No one was strong enough to do it by hand. This is where the turbine took over. The water started spinning the wheel of the turbine and in its turn, the turbine moved the generator. The current went out over the wires across the fields and pastures. Collective-farm workers had erected a long straight line of poles to carry the electric wires.

Where did the current go? From the electric power station it went straight to the collective farm, then it dropped in at every house. In some houses it boiled the water in the electric kettles, in others it brought music from a far-away orchestra. Sometimes it pressed the clothes with an electric iron. On its way to the houses it stopped off at the dairy farm and helped the milkmaids to milk the cows. As soon as an electric milking-machine was plugged in, it started milking the cows quickly and all by itself. Everything changed at the farm. Each milkmaid could now milk two cows at a time with two machines. But electric current can do still more wonderful things than that. In the sheepfold it sheared the sheep closely with electric clippers. The current ground the grain in the mill; at the sawmill it sawed the logs into boards.

The collective farmers were very pleased and proud of their river. "Our river is really wonderful," they said. "At night it gives us light, it brings us news of the world over the radio, and makes it possible to show films, for you need electricity for radios and films, too."

Since then the river has been working for the collective farm. You

might ask where this collective farm is. It's not at the end of the world. There are many such collective farms in the Soviet Union, in which the people have harnessed their rivers. Wherever you go, you'll see electricity at work. In olden times there was nothing in common between the villages and the cities. No matter what village you went to, the sight that greeted your eyes was always the same: crooked little streets, fences, thatched huts, sooty bath-houses, waggons stuck in the mud, and a wooden well with a long squeaky sweep. At night here and there you'd see a kerosene lamp in a window, but it was pitch dark in the streets, and if the moon didn't take pity on a passer-by and give him a little light to see by, he'd certainly get lost. If you came to a field, you'd see a ploughman putting all his weight on his plough and shouting at his half-starved horse; or a sower scattering seeds from a bast basket; or reapers breaking their backs, swinging their scythes monotonously.

Today, in our modern villages, the wooden plough has given way to the tractor-drawn plough, the bast basket to the seed-drill, and the scythe to the combine-harvester. There is a new way of life in Soviet villages today. In the old days, the young people would spend the winter evenings gathered round the only bright spot in the village, a house that had a kerosene lamp. Nowadays Soviet villages have their own clubs, schools, and libraries.

HOW WHEAT WAS GROWN ON WASTELAND

There was a large area of wasteland not far from a village. Once it was a wood, but that was very, very long ago. All that was left of the wood were old tree stumps and a few saplings and bushes here and there. It was stony ground. There were even such big boulders that the

children would creep behind them when they played hide-and-seek. The boys and girls had a lot of fun playing there, and they never bothered to think that so much land was going to waste. But the grown-ups were concerned, for the land was no good for any crop at all. They had long since realized that there was no need for it to be wasteland, but it was no easy job to transform such stony ground into good farmland. That would mean a great deal of work. The tree stumps had to be uprooted, the stones had to be dug out, and the bushes had to be cut down. Sometimes, tree stumps have such huge roots that it's practically impossible to pull them out. And there are boulders that won't budge, especially if they are half-buried in the ground.

One day the children saw workers and machines come to the wasteland. The machines were so unusual-looking that the children had never seen anything like them before. One machine looked like an ordinary tractor from the front, but there was something attached to the back of it that had cog-wheels and an enormous steel spool. A huge wire cable was wound around the spool. The tractor rolled up to the nearest tree stump and stopped. A worker took an axe and made a notch on the stump. Then he slipped a chain around it so that it caught in the notch, and tied the tractor to the stump like you would tie a boat to a jetty.

The children were amazed and wondered why the tractor had been tied up. Was it to stop it from running away? Meanwhile the worker had taken the end of the cable that was wound on the spool and made a noose which he slipped around another stump further off. When he saw that everything was in order he shouted, "Right away!" The tractor-driver pulled a lever, and suddenly all the toothed wheels started turning, just like a clock. Each wheel turned another wheel and they all turned the spool, which kept winding up the cable. The cable became very taut and started pulling up the stump. The children were sure the cable would snap from the strain, even though it looked so strong. It was then that they understood why the tractor had been tied down. If

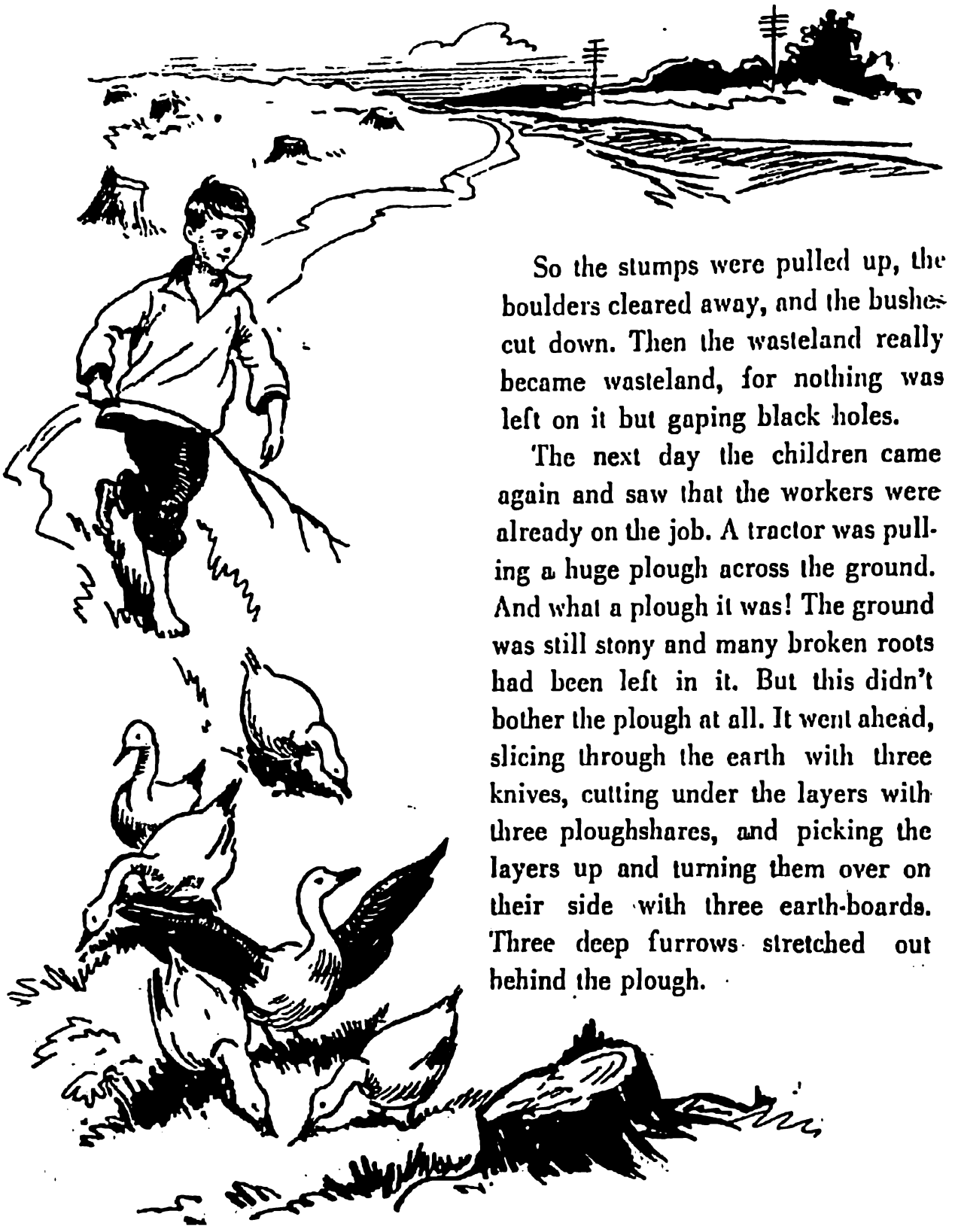
it hadn't been tied down, it would never have been able to hold its ground when it began pulling up the stump.

One after the other the roots started cracking and breaking. The stump started to move as if it were alive. It had held on to the earth with its roots for so many years, and now it was being forced out of its birthplace after so long. Clods of earth started falling from the roots and a black hole appeared in the ground beneath them. As soon as the machine had pulled up the stump, the wheels of the part of the machine the workers called a winch stopped turning.

The stubbing-machine didn't waste a minute and made off to the next tree stump. And so it went along, yanking the stumps out of the earth just as though they were a lot of bad teeth. In half an hour it had yanked out ten stumps.

When the children had satisfied their curiosity, they ran over to see another machine at work, the one that dug out the boulders. As long as people could remember, a huge grey rock had lain in the earth on the wasteland. It was so deep in the ground that only its round grey top was visible. The machine rolled up to the old rock and locked it in its long, crooked steel claws. The tractor-driver drove forward, and the machine plucked the rock out of the earth as easily as if it had been a raisin in a bun.

The children watched for a while and then ran over to see the third machine, for each machine was more fascinating than the next, and they didn't want to miss a thing. This is what they saw: a caterpillar tractor was moving along, pushing a triangular bush cutter, that looked like the bow of a barge, in front of it. On the river the bow of a boat cuts through the water, but a bush cutter moves through the undergrowth, cutting it down as it goes. The small trees it slashed down kept falling on top of it, but it moved them out of the way very nonchalantly and went on, breaking through the thicket and leaving a clear path in its wake. Giant rakes followed behind it and raked everything into piles.



So the stumps were pulled up, the boulders cleared away, and the bushes cut down. Then the wasteland really became wasteland, for nothing was left on it but gaping black holes.

The next day the children came again and saw that the workers were already on the job. A tractor was pulling a huge plough across the ground. And what a plough it was! The ground was still stony and many broken roots had been left in it. But this didn't bother the plough at all. It went ahead, slicing through the earth with three knives, cutting under the layers with three ploughshares, and picking the layers up and turning them over on their side with three earth-boards. Three deep furrows stretched out behind the plough.

By this time all the members of the collective farm had gathered to watch the ploughing. Even the most ancient villager got out of bed and hobbled over. They were all astounded to see their deeply-ploughed wasteland. All this took place in the autumn.

Early in the spring more machines came to the collective farm, but they were very different from the first ones. They still had a tractor, but this time it was doing a different kind of job, drawing a harrow. The harrow loosened the earth with its sharp blades so that the loosened upper layer would cover the ploughed earth below and keep it from drying out.

Some time later the first crop of weeds started coming up, but land that is to be sowed must be completely free of weeds. There was no time to waste, and a machine with sharp steel teeth was put to work. They hooked it on to the tractor and it uprooted all the weeds.

When the collective farmers prepared their fields for sowing, they worked on the new field, too. It had lain idle for so many years, and now, finally, it was going to be useful.

They started sowing it to wheat with a machine called a seed-drill. As the seeder moved along the field, its twenty-four tiny cutters made twenty-four furrows in the earth. The cutters were like iron funnels, each with a sharp steel tip. The steel tip cut through the earth and made a furrow. There was a box filled with seeds on the machine. The seeds poured into the funnels of the cutters and down into the furrows in a steady stream. As the cutters churned up the earth, it fell back into the newly-cut furrows and covered up the seed. A seed-box holds as much as a sackful of seed.

As the summer drew on, wheat sprang up from the seed. When the harvest came, more machines were there to help the people. In olden times wheat was reaped with scythes and threshed with flails. It was hard work. But now a giant called a combine-harvester arrived to give the field a haircut. On one side of the combine there is a kind of reel which looks like an elongated windmill sail. It catches hold of the wheat stems and bends them towards the cutting-machine. There are sharp knives inside the machine that move back and forth and cut off the ears of wheat. The cut ears fall inside the combine and there a threshing-machine shakes the grain out of them.

There's a platform on the combine where the operator stands, turning the wheel and regulating the cutting-machine. When he pulls a cord, a stack of straw falls out of the machine and on to the field. The grain pours through a pipe into a lorry which drives alongside the combine. And it pours out so fast that the only problem is to have enough lorries ready to receive it.

The collective farmers harvested a good crop from their fields, as well as from the wasteland, and so it was wasteland no more.

THE FRIENDS AND ENEMIES OF A GRAIN OF WHEAT

A grain of wheat has many enemies, and if it were not for its powerful friends, it would seldom survive. This is a story about the friends and enemies of a grain of wheat.

Terrible robbers lay in wait for the grain's arrival at the granary. The biggest and fiercest of the robbers was the brown rat, a sharp-toothed fellow who came to the granary from a nearby house and took up residence there, in its underground tunnels. Long, long ago he had come from warmer regions and so he couldn't stand the cold. And no wonder, for his hair was very thin and his ears and tail were bare. In winter the rat lived in a warm house, and in summer he moved to his country home in the granary, so that he would have his food near at hand. In this way he spent his life living off people. People had built houses, people had heated them, and people had planted the wheat. The brown rat lived in a house, warmed himself at the fire, and ate the wheat he hadn't sown.

The grain had another enemy lurking in the granary too—a little nimble mouse. In wintertime he also lived in a house, and that's why he is called a house mouse. In summer he would move into the garden and make himself a home in a hole, just like the one his cousin the field mouse had. In autumn he would settle down in the granary, with the wheat quite handy and the damp outside far away.

The third enemy of the grain was a very small fellow indeed, but he had a great long nose. He was a kind of beetle, called a corn weevil. He lived in a crack in the granary floor, for he hated draughts and always chose the darkest and dirtiest place for his home. He sat in his crack and wondered when the grain would be delivered to the granary. If the weevil could have done what he set his heart on, he would have

ruined all the grain. For besides himself, the weevil had a whole family. positive gluttons for grain. His wife would bore a hole in a grain of wheat, lay an egg in it, and go on to the next one. And so on and so on, until she had laid as many as two hundred eggs. That meant it spoiled two hundred grains. A little worm-like larva hatches from each egg and stays inside its grain-house until it has eaten it hollow.

These are not all the grain's enemies. There were also seeds of weeds. They came to the granary together with the wheat, straight from the field. In the days of its youth, when the grain had rocked in its cradle, the wheat ear, the weeds had tried to steal its water away and snatch all the sun's rays. The most common weeds in the field were wild oats and corn-cockle. Wild oats look rather like the cultivated oats. But actually, there is a big difference between them, for oats are nourishing, and that's why oatmeal is so good for you, while nothing but trouble comes from the seeds of wild oats. Perhaps you've seen corn-cockle growing among the rye or wheat. It has purple flowers and narrow leaves. It's even more harmful than wild oats, for its seeds are poisonous.

The brown rat, the house mouse, the weevil, and the weeds were all enemies of the grain.

The shrewdest enemy of all was very, very tiny indeed. We call it corn smut. This blight tried to get into the grain while the wheat was blooming in the field. It drifted with the wind, for it is like invisible dust. If one of its tiny dust particles, called a spore, falls on the flowering wheat, it takes root there and puts out long threads. As soon as the grain appears in the ear of wheat, these threads penetrate into it and contaminate it.

The grain had many enemies, but it survived, because it had a staunch friend and defender.

When the rat and the mouse arrived at the granary, they found a feast all laid out for them: someone had made lovely pastry from

little pieces of bread and butter sprinkled with sugar. They didn't have much of a feast, though, for the cakes were poisoned. Both the rat and the mouse were victims of their own greed. By the time the grain was delivered to the granary, there were no rats or mice left. Who had saved the helpless grain from its enemies? Its friend, the collective farmer.

The corn weevil was got rid of just as quickly. Some time before the grain had been taken in from the fields, a broom and a draughty wind came to visit the granary. It was a bitter pill for the weevil to swallow, for it hated cleanliness and fresh air. Who was it that had thrown open the doors of the granary and angrily swept the weevil out of the cracks? The same friend as before, the collective farmer.

In order to kill off the weevil once and for all, he sprayed the walls, floors, and ceilings of the granary with a caustic liquid, but he had the hardest time trying to get rid of the weed seeds. They had hoped to get into the granary with the wheat, as if to say, "We're grains, too, and you can't tell us apart from the wheat." But the farmer was not so easily caught out. He realized that though the grains looked alike, they were not identical. Wild oat grain is longer than wheat grain, and that of corn-cockle shorter. But how could the seeds of weeds be separated from the mountain of wheat they were hiding in? Before the wheat was stored away in the granary it had to go through a machine which was a trap the farmer had set up for the weeds. Children who live on farms know what this machine looks like. It's called a screening-machine, or a sifter.

The grain is poured into the top of the sifter; inside it the blades of a fan spin around and blow the air through; the air current carries away dust, bits of straw, and the lightest weed seeds. The grain is too heavy to be blown away by the air and it falls on to the sieve. The sieve moves backwards and forwards and sifts the grain; little stones and clumps of earth remain on the sieve, and the grain falls through its holes.

What happens to the wild oats and the corn-cockle? They are too heavy to be blown away and slip through the sieve with the grains of wheat. They would land right in the sack of grain if it were not for a special trap in the sifter which separates the seeds according to length. What does this trap look like? And how can it tell which seeds are long and which are short? Surely, it hasn't got eyes! You would have to get a good look at the machine to understand all this. In general appearance it resembles a drum. The inside walls of this iron drum are full of little holes of various sizes called cells. Only short seeds can fit into one type of cell, and only long ones into another type. When the seeds are poured into the drum, it first catches out all the long ones and then all the short ones. The drum keeps turning round, and as the cells with the seeds in them reach the top, the seeds fall out and tumble into a chute. They slide down the chute and out of the sifter. The wild oat seeds fall in one pile, the corn-cockle seeds in another, and the grains of wheat in a third. It's a bit difficult to visualize all this when you don't know what the machine looks like, but if you had a chance to watch it sift the grain, it would all be clear to you.

And how did the collective farmer clean the blight off the wheat? Did he win his battle with the blight? It wasn't an easy job, you know,

for the spores were lodged deep inside the grain itself, and this was the grain that was going to be sown. The farmer heated the grain in hot water; after the heat had destroyed the spores, he dried the grain.

In this way, the farmer won his battle against the rat and the mouse, the weevil and the weeds, and the smut. They had tried to outwit him, but he was smarter than the lot of them.

Then the grain came up against other fierce enemies. They attacked it in the fields, after it had been taken from the granary and sown. The fields had been ploughed, fertilized and harrowed—all of which loosened up the hard, caked earth.

The seeds were planted in the ground. At first they were sleepy and motionless, but soon they awoke and came to life. They puffed up from the water in the earth and sent out their first shoots, which drank in moisture through tiny roots. The young stalks started pushing upwards,

towards the light. As each one emerged, it turned its narrow, little green leaf up to the sun. There was another little leaf in the row next to it, and another, and another. The whole field was covered with green shoots.

Things were going very well, but at this point terrible enemies attacked the wheat again. Weeds sprang up here and there among the rows of wheat. How stubborn those weeds were! They started growing and were soon bigger than the wheat shoots. The farmer had to start pulling them up.

The wheat kept growing, its roots went deeper, it began to branch out and store up strength for the long winter ahead. This was winter wheat and difficult days lay in store for it. It would have to spend the winter out in the open field, covered with snow.

The winter guests were not long in arriving. They were Frost and Snow. Frost was the wheat's enemy. Snow was its friend. The little green leaves shrivelled and turned brown with the cold. The frost would have killed the shoots in no time, but the snow came to rescue the wheat and covered the whole field with a white blanket. The wheat began to warm up. It was then that the wind came to help the frost. It blew with all its might and started to yank the white blanket off the field by whirling the snow into the ditches. Luckily, the wheat had become stronger by the time the winter arrived, but even then it had a hard time trying to keep warm. The weather got colder and colder, and the wind howled day and night. The wheat's end was close at hand, but the farmer was determined to save it.

He couldn't tell the wind to stop blowing, or the frost to go away, but this is what he did do: he set up barriers in the field, snow fences made of branches and twigs, stacks of straw, and sunflower stalks.

When the wind decided to blow across the field and sweep away the snow, it was in for a surprise. No matter which way it turned, it was stopped by a fence.

Spring came, the snow melted, and the snow-water was absorbed into the ground. The farmer was pleased, for he had kept the snow in the fields and thus saved the wheat from freezing. At the same time he had stored away water for it in the spring.

Summer arrived, and with it a new enemy: the heat. A hot dry wind blew in from the steppe, and the wheat began to thirst for water—it was now that it needed it most. It had grown taller, and an ear had appeared on each stalk. The wheat needed water, but there was hardly any to be found. If only it would rain, the crop could be saved.

There wasn't a cloud in the sky, no sign of rain at all. The wheat might have died of thirst, but the farmer was there to save it again. He knew the fields had to be watered, but where was he to get the water from? Of course he could tell the clouds to open up and the rain to come pouring down, but he knew nothing would come of this! He was a stubborn man, and he found water. He didn't find it in the clouds, but right in the earth. Some time before he had made an earthen dam across a ditch in the field in which there was a brook. When its water reached the dam it started to rise and gradually made a pond. The farmer dug ditches from the pond to the field, and the water flowed along them right to the plants. The wheat grew very tall; the ears were heavy with golden grain. When harvest time came, the skies suddenly blackened, as if to spite the farmer, and the now unwanted rain threatened to beat down. If the farmer had been slow in harvesting the crop, he would have really been in for a lot of trouble, for the rain would have soaked the wheat stacks. The damp grains would have sprouted little shoots and gotten mouldy. But the farmer didn't waste a minute. He brought a combine-harvester to the field and work was in full swing.

The combine sailed across the field as if it were a ship on a sea of golden wheat. Whenever the driver waved a little flag, a truck would drive up to the combine, and a heavy stream of wheat would pour into it.

The wheat had rewarded its master and protector: several ears had grown from each grain and there were many grains in each ear.

When you bite into a piece of well-baked bread, you should be grateful to the clever farmer who worked so patiently in the fields.

You should also remember the wheat's other mighty friend and ally: the scientist. Soviet scientists work day and night, solving the same problem over and over again in different ways. The problem is: what can be done to make the earth produce more wheat? They have accomplished quite a lot already. For instance, they have found a way of speeding the time it takes wheat to ripen, so that it is able to mature in the steppe regions before the dry winds start blowing. They have developed a hardy variety of wheat for the north, and have found a special way of planting it, so that it can resist the fiercest Siberian winter.

THE GRAIN'S JOURNEY

What is bread baked from?

From flour.

What is flour made from?

From grain.

How is grain turned into flour?

The grain has to travel many miles in the mill before it becomes flour.

A train filled with so many passengers that it was impossible to count them, pulled into a station. They had come from many places, but were as alike as two peas—or many, many peas. The train came to a stop, and the waggon doors were thrown open, letting all the grain-passengers to pour forth. How were the guests welcomed? As is usually the custom,

they were met at the station and taken to a hotel. There's a special hotel for grain and it's called a grain elevator. An underground road, just like the Metro, leads from the station to the grain elevator. The grain travels along the long underground passage-way, changing vehicles at the end of the tunnel, where it is scooped up by a bucket conveyer that takes it to the top floor of the hotel, at the very top of the tower. The tower is so high that it can be seen for ten miles around. It looks down upon the neighbouring houses like a giant looking down on ordinary people.

Why are the new arrivals taken up so high? Just so that they can make their own way after that. The grain pours downwards from the high tower and disperses to the many rooms prepared for it. Some of the rooms are rectangular, like the rooms in your house, and some of them are circular. The grain enters the rooms from the ceiling and goes out by the floor. These circular rooms are so high-ceilinged and spacious that several trainloads of grain can be accommodated in each one. The grain lives in the hotel until its turn has come to go to the mill, which is right next door. What happens to the grain in the mill? Why, it's milled, of course. But there are many different ways of milling grain.

In olden days corn was ground by hand. It was poured on to a round flat stone, a few grains at a time, and ground down with another stone. Every morning the village women would grind the flour for the day, and all through each village you could hear the sound of one stone scraping against another. Pieces of such early millstones are still being discovered. There was a hole in the centre of the upper millstone, so that it could be set on an axis. A wooden handle was then attached to the axis.

These little hand-mills were not much help. At best, a housewife could grind no more than a day's supply of flour at a time. When the towns started baking bread in bakeries for many families at once, they found

they needed large mills to supply them with flour, and so they started making big, heavy millstones. One man could never move such a stone by himself, so a long pole was attached to the stone and two or three men walked round in a circle, leaning on the long handle, turning the upper millstone, and grinding down the corn lying on the stationary bottom stone. A horse was harnessed to the pole to make the work easier and was made to walk around in circle instead of the men. Such a horse-powered mill could grind several sacks of flour a day.

This was still not enough, and the people wanted to find a stronger and better helper. The helper they found worked as hard as whole teams of horses and never needed any food at all. What kind of a worker was it? What was it called? Water. A man works with his hands; a horse works with its feet. Water has neither hands nor feet, but nonetheless people taught it to grind corn. They built a dam across a river and made a pond near the dam. Then they built a big wooden wheel near the dam, outside the mill, and attached wooden scoops all around the rim of the wheel. The water flowed down a chute from the pond, it fell on the wheel and filled the scoops one after the other. The water made them heavy, so they dropped downwards setting the wheel in motion. As soon as a scoop reached the bottom the water poured out and the empty scoop came up for more. That's how the water made the mill-wheel turn.

It also turned a big round grindstone in the mill. The upper millstone is called a runner, because it's always on the go and revolves on an axis, grinding the grain as it turns. The lower one is called a bed-stone, as its function in life is to stay put. They both work, however. The grain pours in through a hole in the centre of the runner and falls into the narrow space between the two grindstones. Their surfaces are very rough and are even grooved. The grain is split in the grooves, and by the time the stones are through with it, it's ground to a fine powder. The people

were happy when they heard the water splashing through the mill-wheel and looked at the white spume. They even made up a song about it. Here it is:

The water gurgles, races round,
It rocks the mill to its thundering sound.
The wheel goes rumbling, lumbering by,
And up the sparkling droplets fly.

The people respected the men whose trade it was to build water-mills, and in Russia they were called water-workers. It was quite difficult to find the right kind of river for a water-mill, but the people of every village needed a helper that could, and would, work.

There is something that you can find everywhere—in the woods, in the fields and in the meadows. What is it? It's air. Currents of air make the wind which blows over the earth, making the rye dip in the fields and the trees sway in the forest, billowing out the sails of ships at sea. Why not make it mill the grain as well? People pondered over this problem and finally invented a windmill. When you look at a windmill from afar it looks as if it is alive, and its waving sails seem ready to fly away at any minute. There's really no reason for it to fly away though, for its job is to mill the grain. A windmill doesn't move its sails all by itself. They are turned by the wind. When they spin round and round they set the millstone in motion, but the wind is a capricious worker. A river always flows in the same direction, but the wind may blow from the south one day and from the north the next. That's why a windmill has to be turned towards the wind and then secured to a post with a strong rope to prevent its sails going round for nothing. There are several such posts set in the ground around a windmill. Then, there are times when the wind decides to stop blowing altogether. The windmill starts turning more and more slowly, until it finally falls asleep, and there's no telling at all when it will wake up.

So things do not always turn out so well! Water can only get to work where there are rivers, and the wind works just when it feels like it.

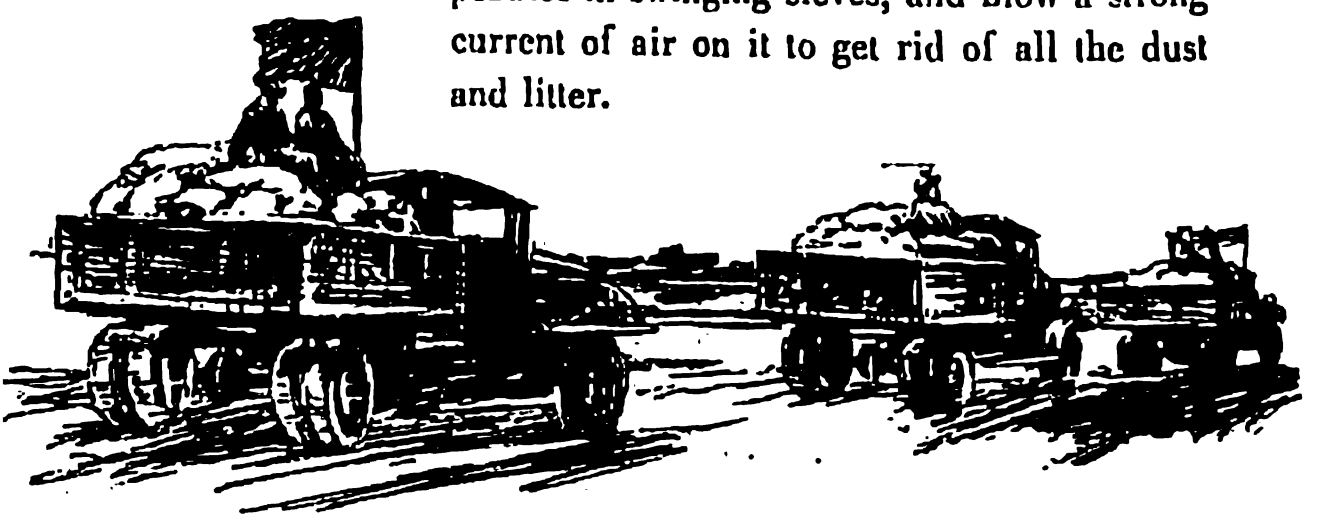
In modern times people have found a much more reliable worker—electricity. The biggest and best mills are neither water-mills nor wind-mills, but electric mills.

A modern mill is a real factory with hundreds of machines that are run on current supplied by a power station.

The grain goes to the fifth floor of the electric mill along a covered bridge from the grain-hotel. The guests are examined at the entrance, to see if some gate-crasher, like a nail or a piece of metal, has tried to sneak in with them.

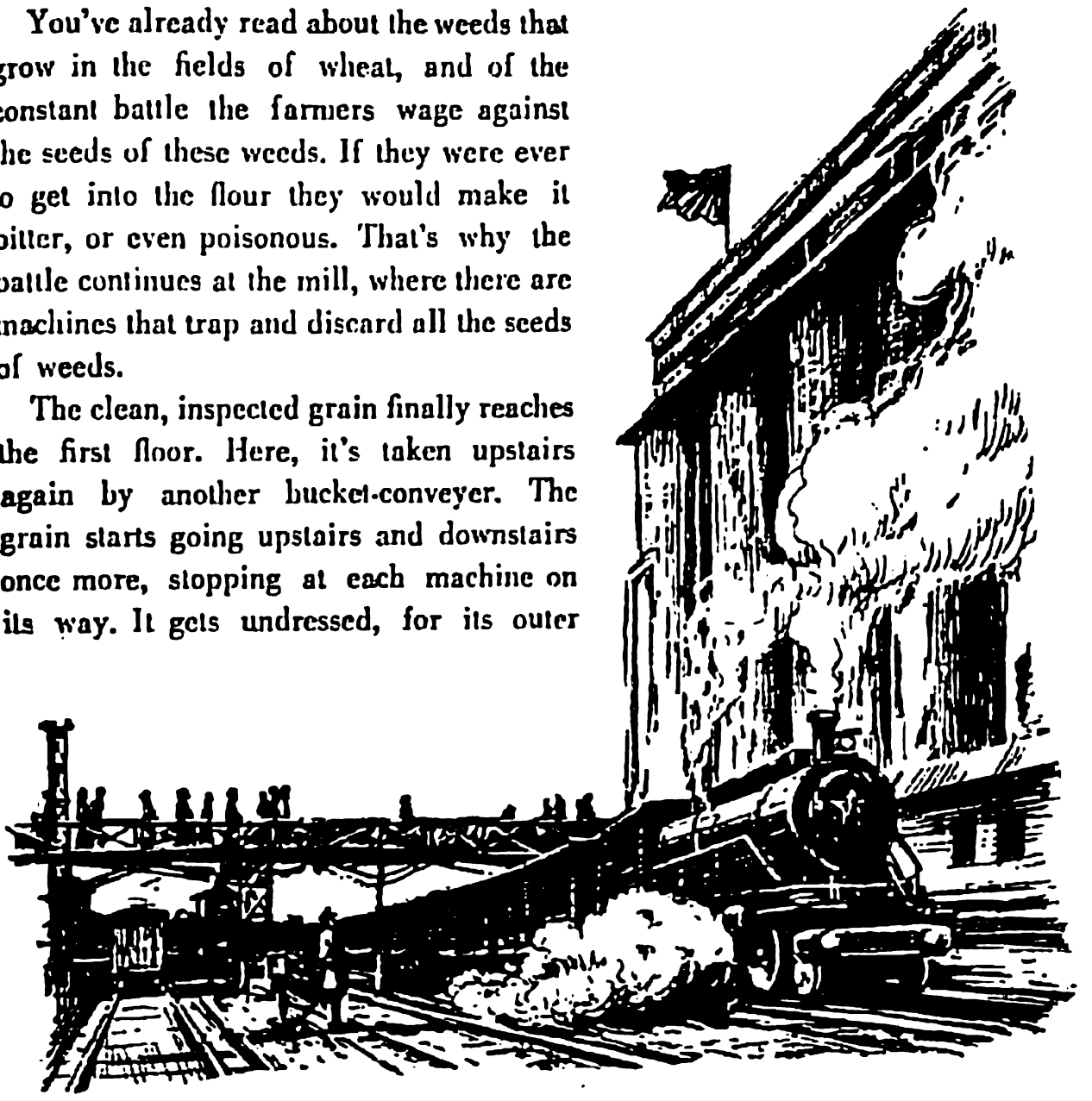
Have you ever seen a magnet attract iron? As soon as you hold it over a pile of nails it pulls them up and there they stick, some hanging on by their heads, others dangling upside down.

There's a magnet in the mill, the same kind of magnet as the little one you have at home, except that it's much bigger. It stands across the path of the stream of grain and pulls out any stray piece of metal that might have got into it. The grain continues on its way, from the fifth floor to the fourth, from the fourth to the third, from the third to the second. There are mechanical watchmen on each floor that say, "Who goes there?" as they check in the grain. They sift out the sand and pebbles in swinging sieves, and blow a strong current of air on it to get rid of all the dust and litter.



You've already read about the weeds that grow in the fields of wheat, and of the constant battle the farmers wage against the seeds of these weeds. If they were ever to get into the flour they would make it bitter, or even poisonous. That's why the battle continues at the mill, where there are machines that trap and discard all the seeds of weeds.

The clean, inspected grain finally reaches the first floor. Here, it's taken upstairs again by another bucket-conveyer. The grain starts going upstairs and downstairs once more, stopping at each machine on its way. It gets undressed, for its outer



jacket is taken off; then it's bathed to make it clean and dried after its bath. When it is dry, it is dampened slightly and put aside until it regains its firmness. Only after the grain has passed through all these stages is it ready to be sent to the milling-machines.

There are rollers in these machines instead of millstones. They look like ordinary rolling-pins, except that they are bigger and longer and are made of cast-iron. The two rollers revolve in different directions at different speeds; the grain pours into a very narrow space between them, where the rollers crush and grind it.

In the olden days, when there were only windmills and water-mills, the millers were always covered with flour from head to toe. A miller's head, and beard, and eyebrows, and eye-lashes were quite white from the flour. The millers in modern electric mills are no longer dusty like this, because special machines suck the flour dust out of the air to prevent it from spreading all over and getting in people's mouths and noses.

A modern mill, equipped with up-to-date machinery, has much more in common with a factory than it has with its own grandfather, the quaint, moss-covered water-mill or the spinning windmill. We still use the old word "mill," but the work is done in a new way. The grain goes through the sieves and other machines many times; it is crushed and sifted, and brushed before it becomes flour; then the bran is separated and the flour is sorted according to grades.

The last machine but one has a trunk like an elephant. A sack is attached to the trunk; when a worker pulls down a lever, fine white flour pours forth from the trunk and fills up the sack in a second. The flour will all spill out if the sack is left open, and that's why it has to be sewn up. A sewing-machine like the one you have at home stitches it.

One, two, three! The sack is closed and continues on its way: from the mill to the warehouse, from the warehouse to the mechanical bakery.

See how many adventures the grain has on its way from the collective-farm field to the hot oven of the bakery! It goes deep under the ground and rises high above it. Like the old saying: "It goes through fire and water."

A large electric mill can grind more grain than a thousand water-mills or windmills, but there are only about fifty millers working at

the mill instead of about a thousand that would be needed to produce the same amount of flour in the old mills. Their clothes are clean, and their faces aren't floured. There's no hard work for them to do either, as everything is done by the machines they operate.

HOW THE CITY GETS ITS BREAD

Most people eat bread, but not everyone knows how it is baked. If you only knew how troublesome the job can be! Sometimes the temperature is too high, sometimes it's too low. Sometimes the dough refuses to rise, sometimes it starts crawling out of the kneading-trough too soon. It's very capricious, for one day it will come out raw inside, and the next day its crust will be burnt.

Long ago each housewife used to bake her own bread. There are still places in our country where the bread is baked at home in Russian stoves. First, the housewife pours water into the trough, then she dissolves some salt in the water and adds yeast to it. After that she pours in the flour, a little at a time, and keeps mixing it until the dough is ready. She then covers the trough and puts it aside in a warm place.

This is when the dough begins to rise. Why does it keep growing bigger? It's not alive. Yet though the dough itself is not alive, the yeast in it is. A piece of yeast is a clump of tiny round fungus cells. Each little cell is too small to be seen through a magnifying glass, and you'd need several of them put together, which is what a microscope is, to see the fungi. When very many fungi are crowded together you can easily see the whole mass of them. They breathe in their own fashion, not at all the same way people or animals do. When they get

into dough they start breathing with all their might, making it bubble and rise.

Care should be taken to keep the fungi warm. That's why the trough is covered with cloths and put in a warm place. When the dough has risen, the housewife kneads it, forms it into loaves, puts it on a special long-handled paddle called a "peel," and pushes it deep into the oven. By the time the children wake up in the morning and rub the sleep out of their eyes, the bread is already on the table, and its delicious smell tingles in their nostrils.

It's wonderful bread, indeed! The inside is moist and full of tiny air-bubbles, for the yeast was at work there and made it spongy. The crust is golden brown and as sweet as caramel. It really is caramel, you know,

for the oven was hottest on the outside of the loaf, and that's where the sugar turned dark and became caramelized. Where did the sugar come from? The housewife certainly didn't put any in the dough! The sugar was formed from the starch in the dough, and the starch was in the flour.

That's how they used to bake bread. Well, and how do they bake it nowadays?

There's a loaf of bread on the table before you. Where did it come from?

From a shop.

How did it get there?

A van-driver delivered it.

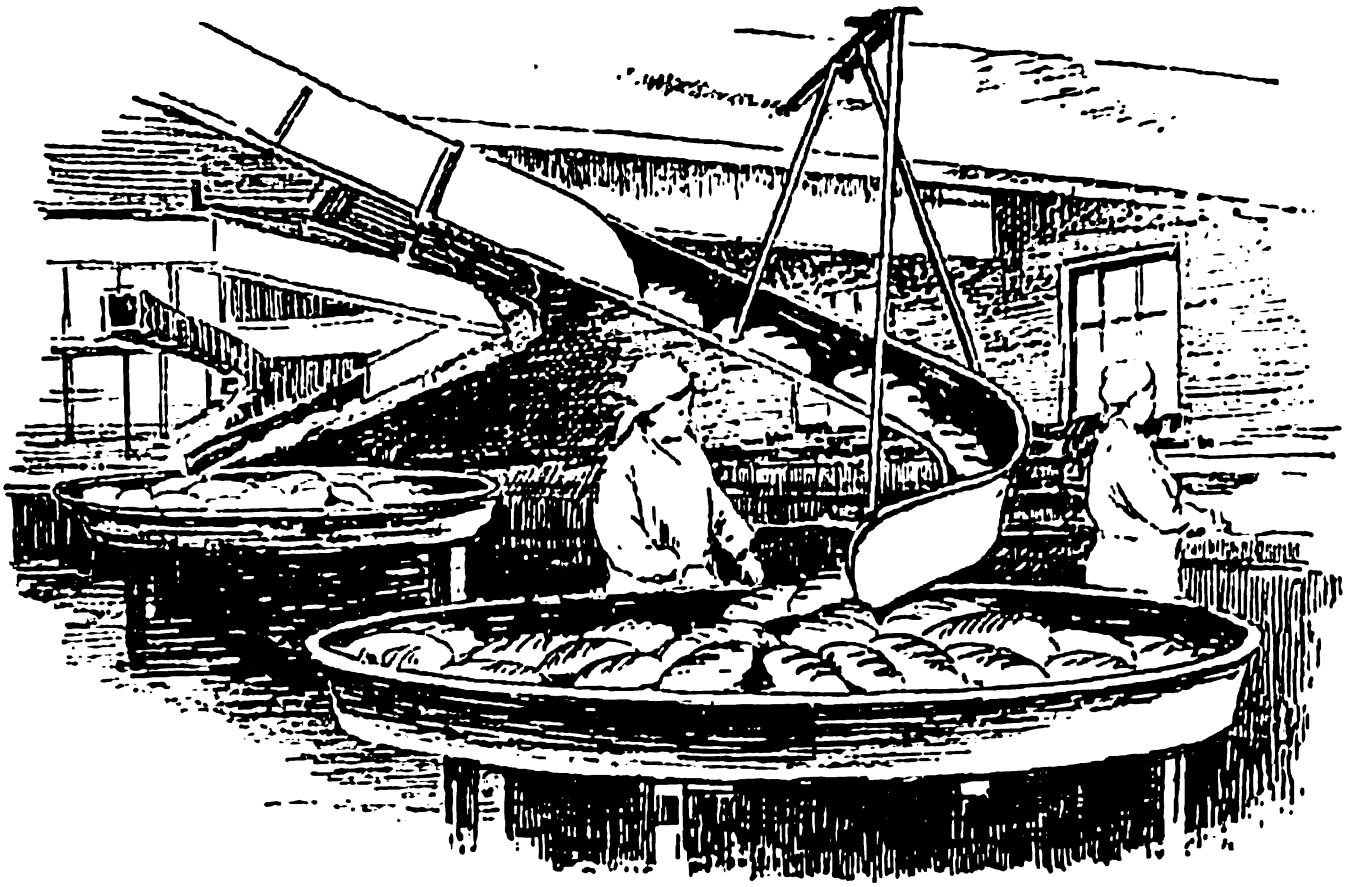
There are many bread-vans in the city and each one has the word "Bread" written on it in big letters. The inside of the van looks like a cupboard and there are wooden trays with bread on its shelves.

Where does the van get the bread?

From the mechanical bakery. A city is a giant. It consumes so many loaves of bread each day that if they were all stacked one on top of the other, they'd make a loaf as big as a house. You'd need a trough bigger than a house to knead the dough for such a loaf.

Can you imagine the size of the peel you'd need, and what kind of hands, to be able to put the giant loaf on the giant peel and shove it into a giant oven! No one in the world has such big strong hands. But everyone does have a head on his shoulders with which to think, and people invented a giant bakery for the giant city.

Everything in the giant bakery is done automatically, as though someone were waving a magic wand. The flour isn't delivered to the mechanical bakery a sack or two at a time, but by the trainload. The sacks slide out of the waggons, down chutes, into a cellar. The new arrivals are met in the cellar and immediately given a rest after their journey. Sometimes unwanted guests manage to creep in with the flour: a piece of string, a splinter of wood, a nail, or a button. Such guests should never be allowed to step over the threshold, for if they get baked in a loaf of bread, nothing good can come of it. You can choke on a splinter and break a tooth on a button. How can they be detected? There's no sense in going through each sack of flour separately. But then, why go through the sacks at all? There's a much easier way of checking up. After the flour has rested from its journey, it's poured through a funnel into a huge pit. It has to pass a control post on the way. First it has to pass by a magnet, which most certainly will never draw flour, but is a lovely trap for iron. The flour continues on its way. What about the splinters, strings, and all the other litter that won't stick to a magnet? How can that be detected? In order to catch all these other objects the



flour has to be sifted, after which it is sent deep into an underground cellar. There it waits its turn to be summoned.

Who will come for it? People? No, not people. One after the other scoop cars come down into the cellar from above. They are brought down by a wonderful bucket-conveyer, not by human hands. It scoops up the flour and carries it up out of the cellar automatically.

One after the other the scoops ride up to the top floor as if they were passengers on an escalator in the Metro. As soon as the flour reaches the top, it starts flowing down in white streams into big bins. It doesn't stay there long, though, for it no sooner enters a bin from above than it leaves through a hole in the bottom.

Where does it go from there?

It starts on a long journey.

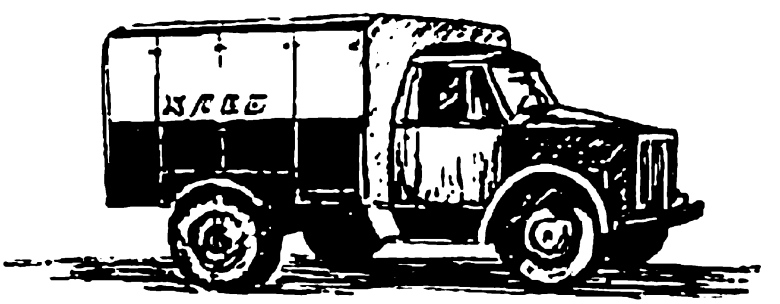
In order to finish up as loaves of bread, it will have to go through many changes. It will turn into dough, get fat and spread out.

The mechanical bakery looks more like a hospital than a factory. The workers there wear white smocks and have white caps on, like nurses. If an outsider enters the factory he has to put on a white smock too. The reason is quite clear, for even though loaves of bread may look like bricks, they're not. They must be clean, otherwise no one will eat the bread.

What do these workers do? First of all, they weigh the flour. The scales here are very special. They weigh out the correct amount themselves, no more and no less than is needed. Although they can't talk, the scales know two phrases. One is: "We're weighing it," and the other: "All ready." A little light flashes on while the flour is pouring on to the scales, to say: "We're weighing it." Suddenly, the light goes off. That means: "All ready."

The scales have weighed out a portion of flour, the exact amount needed for one trough. The troughs here are very special too, not at all like the one a village housewife may have at home. The strongest athlete could never lift all the flour that goes into one trough at the bakery. These troughs could never even be moved if people had not thought of putting them on wheels. It's really not a bad idea at all, for just think how nice it would be if all the pots and pans at home were put on wheels, and the pails could fetch water by themselves!

Where does the trough go? It goes after the leaven, then to the scales for flour, then for water, and for salt. It needs all these things if the bread is to be properly baked. After this, the trough goes to a special hand that mixes and blends everything in it. It's a steel hand, not a human one. When the trough reaches the steel hand it starts spinning around in the same spot. The steel hand goes up and down, it scrapes the sides of the trough and kneads the



dough just as well as any expert baker. Just think how many people are freed from hard work by a single machine!

As soon as the mixing-machine has done its work, the trough is sent off on another errand. This time it's sent to rest, and it starts out obediently for a warm, spacious lounge. There are many troughs there already, and they all seem to be dozing. It's a false impression though, for this is where the main work is being done.

The dough in the trough starts growing as the yeast begins to work. It bubbles and expands in all directions. At the appointed time, after the dough has risen up nice and plump, it starts out again, for everything in the mechanical bakery is done on schedule.

Where's the dough off to now? It's on its way to a knife that will slice it. But first the dough has to be coaxed into leaving the trough. It doesn't feel like getting out, by itself, so the trough is swung upside down to turn it out. There's nothing left for the dough to do, and it grudgingly crawls out of the trough and into a large funnel. It comes out of the funnel looking like a long white snake. This is where the knife goes to work, chopping the snake into pieces. Pieces of dough, however, are not bread: no one eats raw dough. It has to be put into tins and baked. Efficient workers throw the pieces of dough into the bread-tins with such speed that all you can hear is: plop! plop! plop!

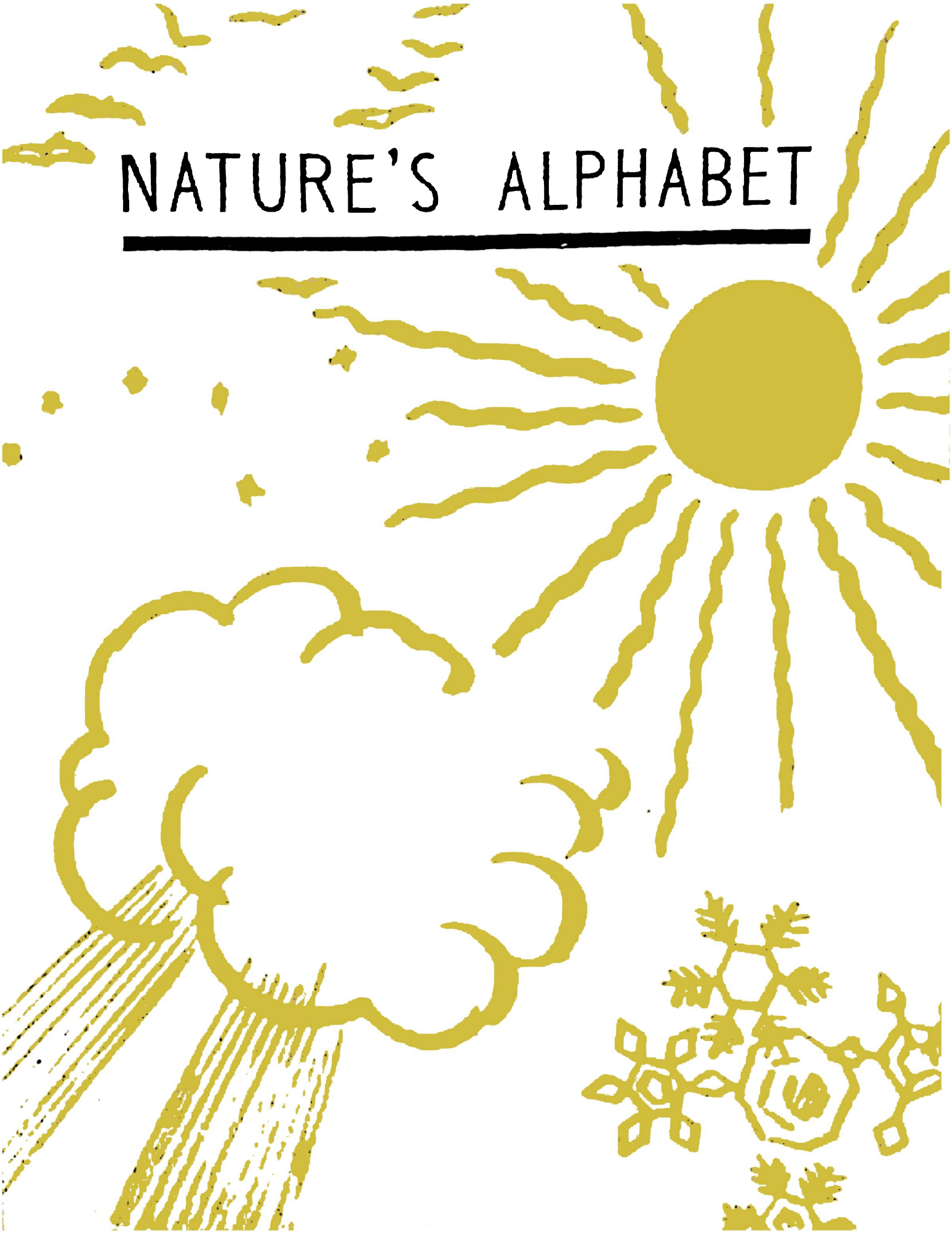
The tins go to the ovens by themselves. A long, wide moving belt carries them along in cradles, as if they were babies. They move forward slowly through a very warm corridor, and the dough keeps getting plumper all the time. It grows and expands as much as it can between the sides of the tins. Since all the tins are of the same size and shape, all the loaves come out the same size and shape too. From the long corridor the loaves go to a blazing oven as tall as a two-storey building. The dough gets baked through and through; it dries out a bit and a crunchy, golden-brown crust forms over it.

The baked bread is met at the other end of the oven. The loaves fall

out of the tins themselves, and those that falter are helped out. They are inspected to see whether they have turned out all right and are well-baked. Then they are stacked on small trolleys with shelves. The loaves stay on the wooden trays on the shelves until they have cooled, for if they are sent to the shops while they're still hot, they will just fall to pieces on the way.

Meanwhile, a steady stream of vans has been driving up to the factory. Each one has the word "Bread" written on it. The back doors of the trucks are thrown open and the trays full of loaves are shoved on to the shelves inside. The bread is on its last journey now: from the van to the shop, from the shop to your shopping bag, from your bag to the plate, and from there you can pop it right into your mouth!

NATURE'S ALPHABET



NATURE'S ALPHABET

You know the alphabet well and can read any sign in the street. You'd never go to the hairdresser's for medicine, or to the chemist's to get a haircut. You can easily find your way, no matter where you're sent, as long as you've been given the correct address: the name of the street, the number of the house, and of the flat.

The alphabet is a very handy thing. There are only twenty-six letters in the English alphabet, but if you know them all, you can read the biggest book and find out about everything in the world.

The greatest scholars all began by learning the alphabet.

However, there's another alphabet which everyone who wants to be really educated must know. That's nature's alphabet. There are thousands of letters in it. Every star in the sky is a letter. Every pebble on the road is a letter. To an uneducated person all the stars look alike, but a person who has studied the stars knows each one by name and can tell you in what way each one differs from the rest. Just as words are formed by letters, so the constellations in the sky are formed by separate stars.

Sailors have been consulting the star-book for centuries. Whenever they have to find their way in the ocean, they look to the stars, for no ship ever leaves traces on the water. There are no sign-posts with little fingers saying "To the North" on them, and even if there were, the sailors wouldn't need them. They have an instrument called a compass which has a magnetized needle that always points to the North. If they didn't have a compass, they'd look for a constellation called the Little Dipper, and for the North Star among the stars of the Little Dipper, which is always in the North.

Clouds are also letters in the sky-book. They tell you of the present and can even foretell the future. The clouds can predict a storm or a rainy spell even on the fairest of days.

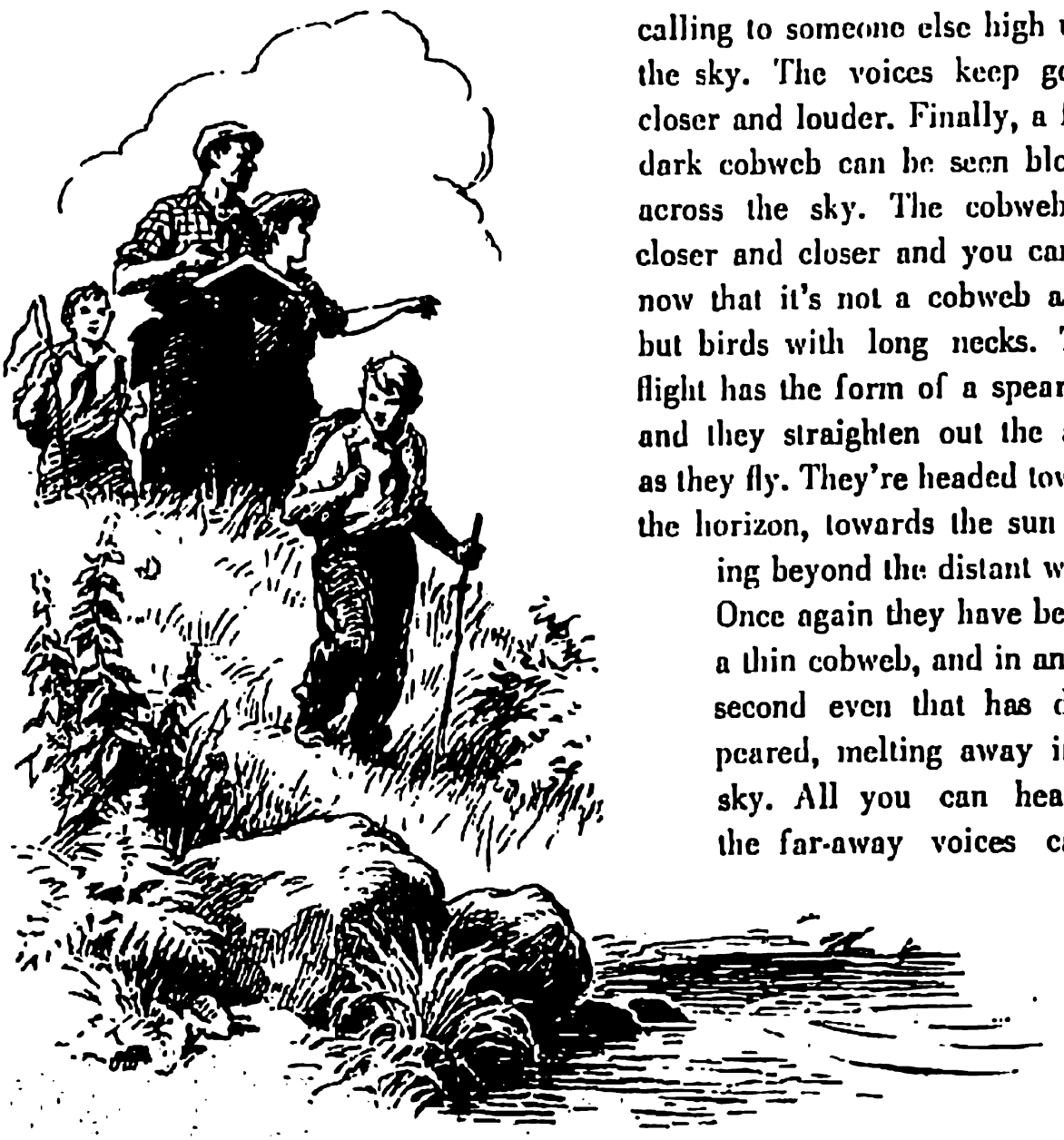
If the sky is covered with white, wispy, woolly clouds, a person who knows nature's alphabet will tell you that they are banks of cirri and that they never bring good news, as they usually predict rainy weather.

Sometimes, on a hot summer's day, the clouds in the distance start piling up into white mountains. Then you notice that the sides of one of the cloud-mountains are changing and are becoming pointed, making the cloud look like a blacksmith's anvil.

Aviators know a cloud-anvil heralds a storm, and they keep far away from it. The wind inside a cloud like this is so strong that it can break up any aeroplane that flies into it.

The birds can also teach us many interesting things if we observe their sky-wanderings carefully. High-flying swallows mean fair weather ahead; in Russia and northern countries spring is never far behind the first rooks; and when the last cranes fly away, you don't need a calendar to tell you that the warm days of summer are over.

It's a still, clear day in early autumn. The sun is warm and bright. Suddenly, the quiet is broken and strange, alarming cries ring through the air. It's as if someone were calling to someone else high up in the sky. The voices keep getting closer and louder. Finally, a faint, dark cobweb can be seen blowing across the sky. The cobweb gets closer and closer and you can see now that it's not a cobweb at all, but birds with long necks. Their flight has the form of a spearhead and they straighten out the angle as they fly. They're headed towards the horizon, towards the sun shining beyond the distant woods. Once again they have become a thin cobweb, and in another second even that has disappeared, melting away in the sky. All you can hear are the far-away voices calling



out to you, "Good-bye! Good-bye! We'll come back again in the spring!"

There are so many wonderful things you can learn from the sky-book.

However, the ground under our feet is also a fascinating book if you know how to read it.

A labourer digging a foundation hits a grey stone with his pick. As far as you're concerned, it's just another stone, but a person who knows nature's alphabet knows that this is limestone. It was formed from tiny sea-shells, which means that many millions of years ago there was once a sea where the city now stands.

Sometimes, if you are walking through the woods you may suddenly come across a huge granite boulder, all covered with moss. How did it get there? Who was strong enough to drag such a rock into the forest? And how could it get through the thicket?

A person who knows nature's alphabet will tell you that the boulder was brought by a glacier, not by people. The ice slid down from the cold north, cracking the cliffs in its path and carrying off fragments of rock. All this happened long, long ago, when there was no trace of the forest and it was only much later that the trees grew up around the boulder.

In order to learn nature's alphabet, you must start exploring the fields and woods very early in life and examine everything you see there very carefully. If there's something you don't understand, you should try to find out whether a book might not have the answer you're looking for. You should never miss an opportunity of asking someone who knows: "What kind of a stone is this? What kind of a tree is that? What's the name of that bird? Who made these tracks in the snow?"

A lazy stay-at-home will never learn nature's alphabet. We once knew a boy who loved to read fairy-tales about dragons, and mermaids, and magicians. There's nothing wrong with reading fairy-tales. The sad part about it, though, was that he didn't want to and didn't know how to

read the most interesting book of all—the book of nature. How could he read it, when he didn't even know the alphabet? He couldn't tell one tree from another or one bird from another. Once his friends talked him into going blackberrying with them. He got very excited when he saw a lot of juicy, red berries growing on some bushes, and he thought to himself that even though he hardly ever went berrying, this time he'd pick the most of anyone. He picked a basketful of berries and started out for home, but he couldn't resist popping a few into his mouth. A little later he felt sick and then he got a stomach-ache. Luckily, he vomited, otherwise he would have been poisoned. You can be sure he never ate those berries again. Nature herself taught him to distinguish the good from the bad. But nature is a very stern teacher: she punishes those who don't know her alphabet severely. If this boy had gone to the woods more often with grown-ups or with older children, they would have told him that although the berries he had found were pretty, they were poisonous.

Once the children called this boy to come and help them weed the garden. He kept finding excuses for not going and finally said, "Wait a minute, I just want to finish this story." "All right," the children said. "We'll leave you a couple of rows to do." The boy finished reading the story and went out to the garden. He was the kind of fellow who couldn't tell a carrot from a weed. Well, he started weeding. And what do you think? He yanked out all the little carrots and left all the weeds!

He certainly had a hard time of it when they came to look at his handiwork. His mother scolded him, and all his friends teased him for days afterwards. The boy had good eyes, but he didn't know how to look at things. He used to walk in the woods and never see anything; he would walk by a nest and not notice it; he would see a porcupine only after he'd stepped on its sharp needles; he couldn't tell a dog's track in the snow from a rabbit's.

One day in spring he went for a walk in the forest and got lost. Any other boy would have remembered that his house lay to the south, where the sun shone, and that there was no need to worry just because the sun was hiding behind some clouds. You can still find out where the north or the south is, even if there is no sun. Moss grows on the northern side of trees; the snow melts on the southern side of a tree before it melts on the northern side, where the sun's rays can't reach it.

This alphabet is for those who know how to read the book of nature. The whole trouble was that this boy didn't know the alphabet. That's why he wandered about the forest till nightfall, when he came upon a strange village and had no other choice but to spend the night there. You can imagine what was going on in his own house! His mother was crying her eyes out, because she thought he'd been eaten by wolves!

There's really no sense in taking up so much space with such a boy. You won't ever be like him, for you are observant and examine everything around you carefully. When you grow up and become an engineer or an aviator, a captain or an agronomist, the book of nature will be as clear to you as any book that is printed on paper.

THE INVISIBLE ONE

Do you think that invisible creatures exist only in fairy-tales? Then look up at the sky. See the clouds floating way up there? What is pushing them? The Invisible One. When it crosses a field, the wheat bows low to it; when it passes through a forest, the trees bend down their heads. This morning it tore the linen off a clothes-line, knocked off a boy's cap, snatched a newspaper from the table and sent it flying to the floor. It

asked no one's permission before it came in and didn't even bother to knock. In fact, it didn't come in by the door at all, but through the window.

In autumn it whirls the dry leaves down the street; in summer it beats up the dust and tosses it into people's eyes. It has so many adventures in its journey across the steppes, over the forests and seas! This Invisible One brings down the cold from the north and the heat from the south, rain from the seas and dust from the deserts. It billows out the sails of yachts and turns the windmill sails to grind the corn.

You've surely guessed what it is by now. It's the wind, the invisible current of air that moves over the earth.

The story you're going to read now will tell you about the wind's adventures.

Far in the north, in the Kingdom of Ice, lived the Invisible One, known as the Northern Air. It would often blow across the ice-fields, sweeping up the snow in its path. Sometimes it would raise clouds of snow-dust, and then chase after the dust across the fields of ice. What other playmate could it have in a snow kingdom?

Oh, how cold it was in the north! The sun never rose very high, nor did it shine for very long, and the Invisible One never had enough time to warm up during the short day. At night things were still worse. It hardly ever had a chance to snuggle under a fluffy cloud-blanket. The nights were usually cloudless and starry, and by morning the Invisible One would be quite frozen.

There came a day when it managed to escape from the Kingdom of Ice and started out on a long journey southwards.

Its way lay over an ocean. The water in the ocean was warmer than the northern ice, and as the Invisible One sped over the warm water, it gradually began to thaw out. There were many things it could play with there. It pulled the water up into waves, and the faster it sped along, the higher the waves rose. As they moved along in rows, the

Invisible One tore off their caps and beat them into white foam. Sometimes it came across ships and played with the smoke that streamed out of the stacks. It found other work too, and washed and re-washed the decks with ocean spray, although the sailors had swabbed them down already. It nearly washed a passenger overboard, and it was his good luck that he managed to catch hold of the rail.

The Invisible One went on its way, rocking the ships and fishing smacks with all its might. When it left the Kingdom of Ice it had been frozen through and through, but as it passed over the ocean it thawed out and stored up some of the water that rose from the ocean in an invisible mist. The mist became minute drops of fog, which the Invisible One carried off and spread close over the water, blotting out the sun.

Somewhere over the ocean the Invisible One blew straight into an aeroplane. It was very pleased to find such a toy and started tossing it around, enveloping it in a white blanket of fog. The pilot's first thought was to get out of the trap, and he made the plane climb higher and higher, until the snow-white fog was left far below and the sun's rays had found their way into the cockpit.

The Invisible One sped along very fast, but it still had far to go. It took it a long time to reach the shore, where it filled the streets of the coastal cities with a thick pea-soup fog; the street lights in Leningrad flickered dimly through it; drivers kept honking their horns in warning, for the cars could not be seen in the fog. The Invisible One went on its way, travelling further inland. No one could see it, but everyone saw what it was carrying with it from the sea. The little drops of water had gathered into big drops, and heavy clouds hung low over the earth.

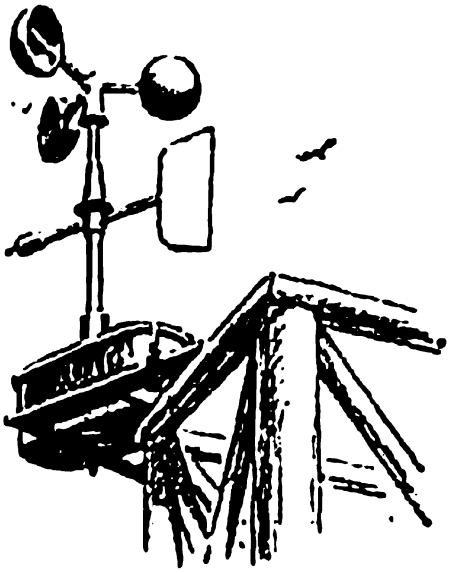
Suddenly, there was a flash of lightning and a loud clap of thunder. The children who were swimming in a stream heard the thunderous voice of the invisible traveller and scrambled out of the water, for they wanted to get home before the storm. The Invisible One poured the ocean water on the fields and forests and continued further south.

There was another master in the south. It was also invisible, and was called Southern Air.

The two Invisible Ones had argued many times before, as neither would give the other the right of way. And they argued this time, too. The battle between the two giants began. When two invisible giants are fighting it out, the best thing to do is to keep as far away from them as possible. When they are whirling around, the cyclone they create can pull a tree up by its roots, sink a ship at sea, or smash up an aeroplane in flight.

As soon as people find out that a storm is approaching, they start preparing for it, and no matter how fast the Invisible Ones travel, the radio and telegraph wires carry their messages still faster.

The telegrams say: "Sailors, beware! A storm is approaching!" "Fishermen, don't put out today! A storm is approaching!" "Pilots, be



careful! A storm is approaching!" "Farmers, stack the hay! A storm is approaching!"

Who is it that tracks down the Invisible Ones? Who is it that knows beforehand which way they are headed, and where they will clash?

It is the meteorologist who knows all this. Meteorologist is a long, difficult word, but you should read it carefully and memorize it. The meteorologists are our friends. They are the watchmen who are posted everywhere: in the mountains, on the plains, on islands in the sea and in the deserts, in the Kingdom of Ice where the Northern Air lives, and in the realm of its enemy—the Southern Air. There are weather stations everywhere, and the meteorologists in these stations observe the changes in the weather, keeping track of the two Invisible Ones. The meteorologists have helpers. One of them is a weathercock. It is perched up on a high post, and as its finger turns in the wind it shows where the wind is coming from. Another helper is a thermometer. This one shows how hot or cold it is. Still another helper is called a hydrometer, and shows how damp or how dry the air is. A fourth helper is a rain-gauge which measures the amount of rain that has fallen. A fifth helper is a barometer, a really wonderful instrument. If its arrow points far to the right, there is fair weather ahead. If it goes way over to the left, you can expect a storm or hurricane.

The meteorologists at all the weather stations in the Soviet Union keep checking their instruments and telegraphing their findings to Moscow. There's a tall, red-brick building in Moscow, topped by a little tower with a weathercock and a whirling instrument that measures the speed of the wind. This is the home of the Central Weather Bureau. The meteorologists in the Central Weather Bureau are in touch with all

the weather stations. They mark off rain areas, bright areas, and cold areas on their weather maps. And so, by taking everything the instruments have measured into account, they are able to forecast the weather.

When the meteorologists compare today's weather chart with yesterday's, they have a clear picture of how the weather changes across the country, and it's not too difficult for them to forecast tomorrow's weather.

The weather forecast is transmitted by telephone, telegraph and radio. When you turn on the radio you hear: "At the signal, the time will be 7 p.m. Here is today's weather. It was —4° Fahrenheit on Dikson Island, —14° in Yakutsk and +18° in Moscow. Tomorrow will be cloudy with strong winds."

Let's get back to the story of the two Invisible Ones. The battle between the two giants called Northern and Southern Air was about to start, but the people had already been warned. The farmers were hurrying to stack the hay before it got wet; the pilots were taxying their planes into the hangars; the fishermen had called off all fishing until the storm blew over.

The battle was on. It started when the Southern Air climbed on to its enemy's shoulders. Light banks of cirri appeared high up in the sky, covering the vast expanses with a white film. The clouds kept getting darker. Then, far off in the distance, a grey wall of rain appeared. It was approaching rapidly, and soon enveloped the woods and ran across a field. "Tap-tap-tap!" the first drops spattered on the window-pane. "Please, let us in!" They were followed by others, which spattered the roofs, the leaves, and the park benches. It looked like a long rainy spell, but gradually the clouds parted, the sky cleared, and it became hot. The Southern Air had won and had penetrated deep into its enemy's territory. How long would its victory last?

The Northern Air would not accept defeat. It circled round to the enemy's rear, and an avalanche of cold descended on the Southern Air and tossed it high up; the sky was suddenly filled with mountains of clouds. A terrible storm ripped across the earth, breaking branches off the trees, raising pillars of dust, and whirling the leaves on the ground. Luckily though, the people had again been warned of the approaching storm and were prepared to meet it.

Who won the battle? The Northern Air. It raced further inland until it reached the Ural Mountains, but they didn't stop it at all. It by-passed them from the south and headed past the Caspian Sea towards the desert. What a change came over it then! It had been damp sea air, but in the desert it became hot, dry, and dusty. It was hard to tell it from the defeated Southern Air!

And so, the Invisible Ones roam the earth and bring rain, storms, snow, and frost with them.

Meteorologists keep a sharp look-out for the Invisible Ones in order to warn farmers of a coming frost, pilots of fog, and railwaymen of snow-banks on the line.

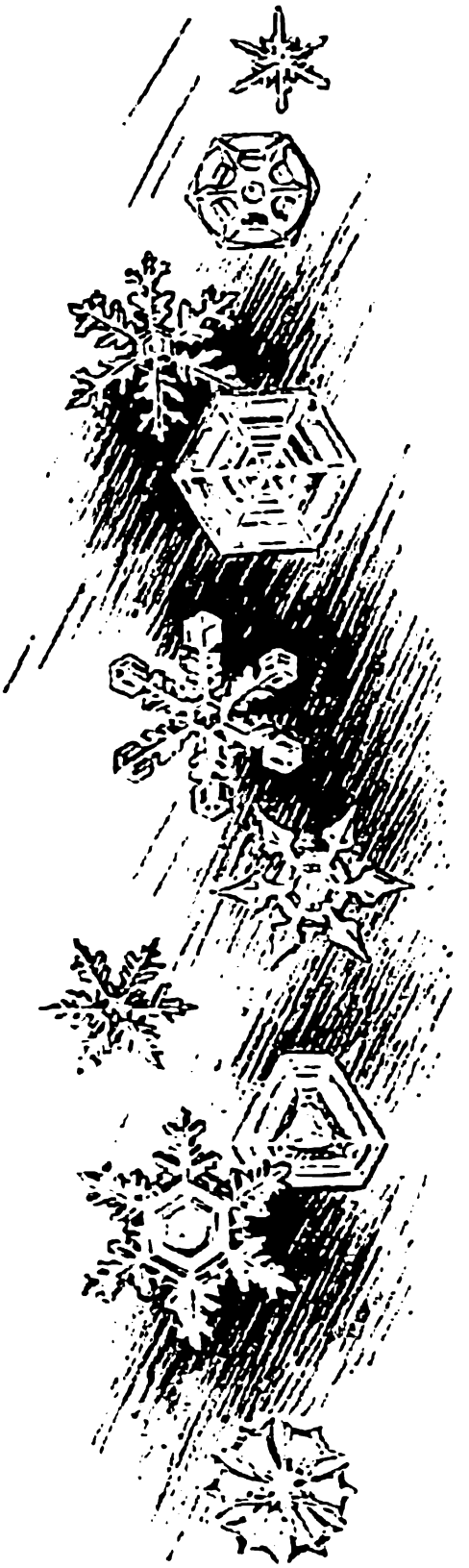
SNOWFLAKES

Once upon a time, there lived some snowflakes. They were born in a snow-cloud high above the earth and began growing the minute they were born. They became more dainty and beautiful with every passing hour, and although they all looked alike, as sisters do, each one had its own lovely dress. One looked like a star with six points, another like a flower with six petals and a third sparkled like a six-sided precious stone.

The snowflakes grew up and drifted down to earth in a white flock. There were so many falling, that it was impossible to count them. They floated very close to the earth, but the wind didn't want to let them lie down. It kept whirling them around in the air, spinning them up and down in a mad dance. Yet, they still managed to reach the ground in a steady stream. They settled down like fine ladies taking care not to crush their lovely gowns.

Some snowflakes came to rest on a stubble field; others found a bed in the forest on the branches and underneath the trees; some went to sleep on the roofs. There were careless ones that settled down in the middle of country roads or city streets, and their fate was sad indeed, for with the morning came walking people, waggons, and lorries. The snow-flowers and snow-stars melted under the many feet and wheels that trampled them: they were mixed with dirt, and hay, and mud. A regular campaign was launched against the city snowflakes, which were shovelled, swept away, and scooped up by machines. By noon the last sign of winter had vanished on the shiny, black asphalt streets. There was a good reason for cleaning the snow off the streets: it slowed down the trolleys and buses and made the cars skid.

The collective farmers welcomed the snow. The slush and mud brought on by the autumn



rains was a thing of the past; they were now able to change their waggon-wheels for runners and fly along the smooth white roads. Children made snowballs from the snowflakes and moulded thousands of delicate snow-flowers and snow-stars into bulky snow-men. Presents don't often drop from the sky, and the children had to hurry, for it was quite possible that the white present would melt.

The snowflakes were saved by the frost that evening. It shooed all the children home to their warm beds, and when they awoke the next morning, everything was white. The streets were trampled by feet in warm boots and flattened by sleigh runners. It was nice to hear the snow crunching underfoot and the runners screeching along the roads. No one realized the crunching and the screeching was the cracking and the splitting of the petals and rays of snow-flowers and snow-stars.

The snowflakes that had gone to sleep in the field rested much more peacefully, as no one bothered them for a long time. The farmers knew that the snow would cover and protect the green shoots of winter wheat from the frost. The snowflakes would have remained in the same spot all winter, just like little sleeping beauties, if the wandering wind had not come upon them. It tore across the field and started to scatter them, blowing them from their beds and whisking them away. They might have circled over the field endlessly, but at one end of it there was a ditch. They hid away from the wind in the ditch and were happy to have found a quiet place at last.

But, alas! They were much worse off in the ditch than they had been before. At least, they hadn't been cramped when they had been out in the field. There, in the ditch, they were packed in hard, and new crowds of fugitives kept arriving every minute. They pushed each other about and their lovely petals and rays broke in the crush. No one could tell them apart any more, for they had become a solid pack of broken pieces.

It was then that the farmers decided to take a hand in the matter,

because they didn't want the wind to blow all the snow off the field. With the coming of spring the field would need the snow-water, but all the snow was in the ditch. That's why they decided to stop the wind from robbing the field. You've already read the story of how they put up all kinds of barriers to keep the snow on the fields.

The snowflakes that settled in the forest were most fortunate of all, because the trees there held back the wind and prevented it from disturbing their sleep. It's quiet in a forest. From time to time an animal would scamper by and leave its tracks in the snow. The soft, fluffy snow-drifts kept growing higher and higher between the trees. The snow was only knee-high in the fields, but you'd fall into a snow-bank up to your waist if you ventured into the forest without skis.

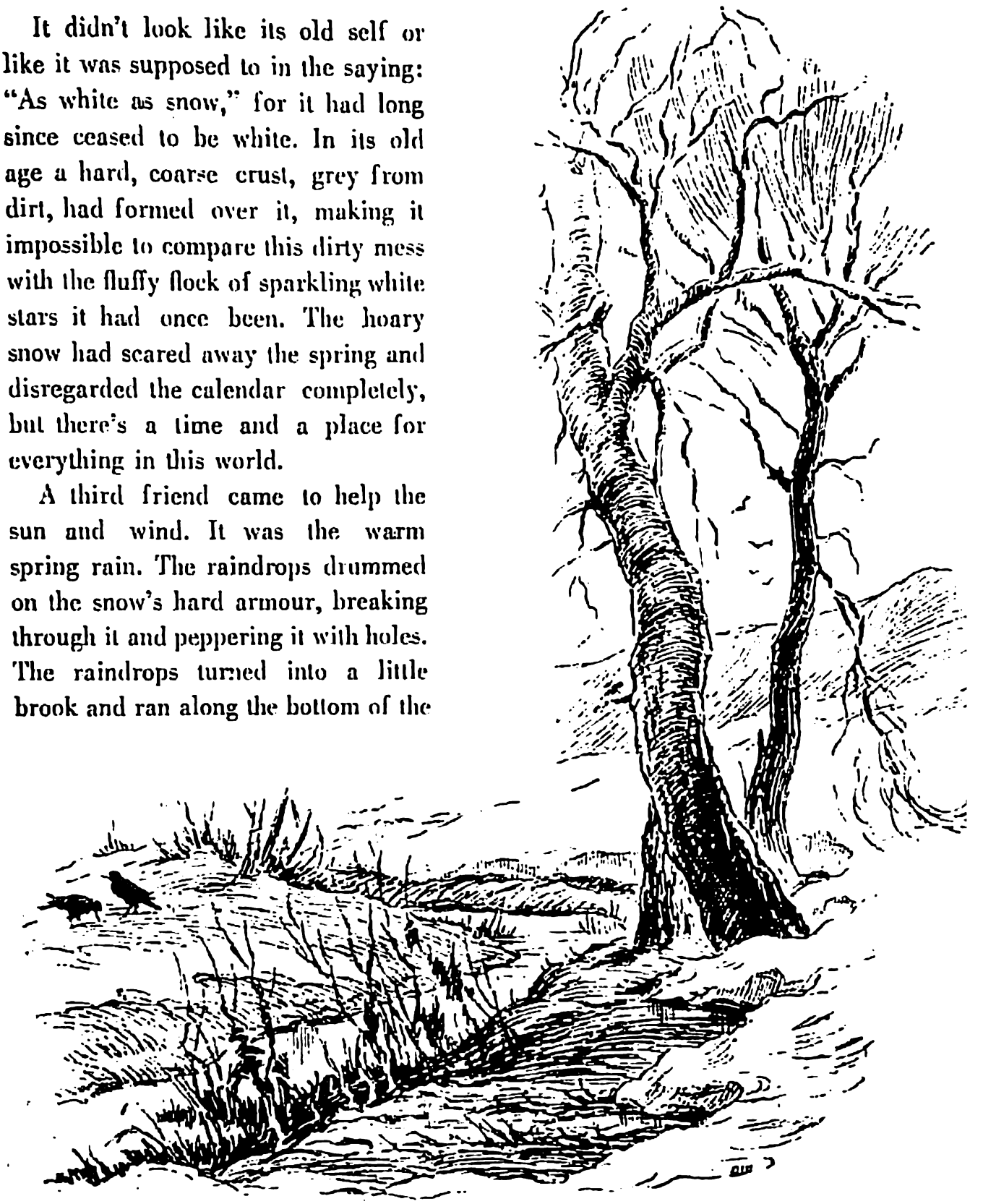
But even in the forest the poor snowflakes could not find peace or save their gowns forever. What happened to them? You'll have to wait till spring to find the answer.

HOW THE WINTER FOUGHT AGAINST THE SPRING

It snowed most of the winter, and snow-storms kept sweeping the snow into valleys and ravines like an industrious care-taker; the sun kept climbing higher and shining for a longer time each day; the roads had been cleared of snow for some time, but the fields were still white, for there the snow stubbornly resisted the sun's rays, it reflected them as in a mirror, and made it hard to look straight at it. Suddenly, a southern friend appeared to help the sun. It was the warm south wind, which had come from regions where the summer had conquered the cold. The battle was an uneven one, because now it was two against one; the sun pierced the snow with its rays, and the wind blew warm air on it until it began to give in. At first it started melting in the fields, where the sun and wind had a free hand, and soon bright green grass began poking through the ground. The sun and wind had a much harder time trying to get into the valleys, the ravines, and the ditches, because the snow there seemed glued to the ground.

It didn't look like its old self or like it was supposed to in the saying: "As white as snow," for it had long since ceased to be white. In its old age a hard, coarse crust, grey from dirt, had formed over it, making it impossible to compare this dirty mess with the fluffy flock of sparkling white stars it had once been. The hoary snow had scared away the spring and disregarded the calendar completely, but there's a time and a place for everything in this world.

A third friend came to help the sun and wind. It was the warm spring rain. The raindrops drummed on the snow's hard armour, breaking through it and peppering it with holes. The raindrops turned into a little brook and ran along the bottom of the



ditch, under the hard crust of snow that was still strong on top, but no longer had anything to protect, as the snow beneath it had melted away. The crust was doomed; it kept breaking, crumbling and melting, changing from dirty old snow into a lively, young, gurgling brook. A snowflake is lovely. But is a transparent drop of water reflecting the spring sky less lovely?

The last to give up was the snow in the forest, where the tall pines and firs were like a fortress wall protecting it from the wind. Even the sun's rays got lost in the thick green needles of the branches.

The snow finally had to give up in the forest too, first in the clearings and then in the dense thickets, where the sun's rays were blocked out by the tree trunks, but were still able to warm through the trunks. The sun warmed them from morning till night, first on one side, then on the other, making the snow melt quickly in a dark circle around each tree trunk.

And so the sun, the wind, and the rain chased the snow from all its hiding-places in the valleys and ravines, and from the dense thickets in the forests. The lazy snow woke up and ran down towards the rivers along furrows, ruts, ditches, and dry ravines.

THE WATER'S ADVENTURES

The ice broke and the stream overflowed. It became so wide that it was hard to recognize it. Ice-packs floated along in a white flock, bumping into one another, spinning around, jutting sideways out of the water, and turning over. If one got stuck near the shore, the others would nudge it on. There were tracks of runners on the ice-packs, in the places where

sleighs had crossed over the ice in winter. It seemed as if a piece of road had been swept away and was floating along with the current. The ice-packs floated from the stream into a big river, and the river took them down to the sea. They started melting on the way, leaving the river free of ice; then the river had to return to its banks.

The water in the river has to travel very far to reach the sea and has so many adventures on the way! It washes away the banks, it grinds down stones, it carries sand and clay along, and piles them up into sand-bars and little islands. But people don't let the river get away with such things. To prevent sand-banks from interfering with river traffic, huge floating machines are sent out into the river. They deepen the river-bed by scooping out the silt and sand with dozens of scoops. These machines are called dredgers.

In order to make use of the power of the current, people let the river carry logs from the forest to the sawmill, and deliver loaded barges from one city to another. They build dams across the river and erect electric power stations next to the dams. There are many large and small

hydro-electric power stations in the Soviet Union. There are giant stations that supply current to many factories, cities, collective farms, and railways at the same time. There are those, too, that only supply enough current for one collective farm.

The river is sent on many errands before it reaches the sea. It's made to flow into water-pipes and go into houses; locomotive boilers are filled with it and it turns into steam in the boilers, making the heavy trains speed along the rails. It's sent to factories, into water-tanks, and through chemical apparatus; water cools off overheated car motors when it's poured into the radiators; it washes the streets and puts out fires.

And so the water that fell somewhere in the forest as winter snow, finally reached the sea. The road to the ocean lay before it. Ocean currents took the water far to the south, to places where the sun is directly overhead at noon. The hot rays of the sun turned the water into vapour and it was off again, this time by air. The wind carried it towards the shore, and there it fell on the ground as rain and hail.

HOW A HAILSTONE WENT A-VISITING

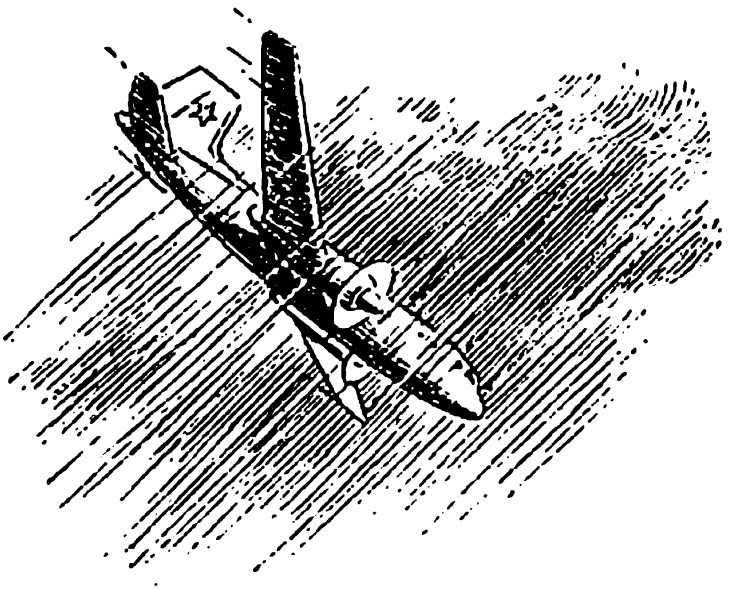
A little hailstone fell on the ground and bounced along the path like a ball.

Where did it fall from?

From the sky.

How could it grow so big and heavy in the sky? What held it up?

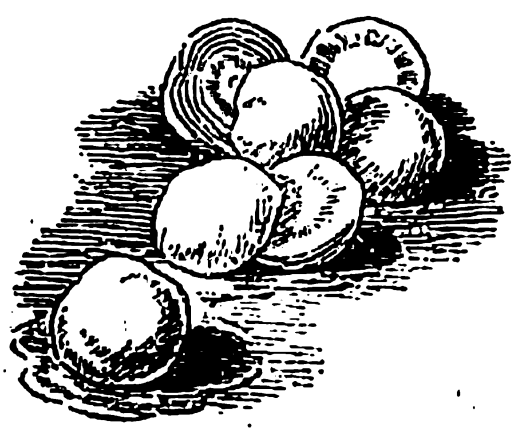
It will tell you its story itself. But you'd better be quick with your questions, before it melts away. Look under that bush! Do you see the hailstones that have rolled there? Pick up the biggest one and get out



your penknife. Now, cut the hailstone in half. It's as transparent as glass on the outside and as white as porcelain inside. Of course, it's not porcelain, for porcelain doesn't melt. It's snow. And the glass isn't glass at all. It's ice.

Now we've found out the hailstone's secret: it's made of snow, like the fairy-tale Snow-Maiden, and its dress is made of pure ice. This wasn't the prettiest hailstone, however. Some of them wear as many as three or five petticoats. First there's a transparent ice petticoat, then a white snow petticoat on top, and finally an ice dress on top of the last snow petticoat. Where do they get into all these petticoats when they decide to go visiting? Why, at home, of course, high up in the sky.

A hailstone has a hard little white nut in the centre. This little snow nut was born in a snow-cloud and started falling down to earth, but it had a very long way to go. There are many clouds in the sky, and the snow-clouds are higher up than the rain-clouds. On its way down the hailstone met a rain-cloud, which gave it a water petticoat. The dress froze on it and became an ice petticoat. But how did it get a white snow petticoat on top of its ice petticoat? When it came out of the rain-cloud it didn't fall towards the earth, but climbed up to the Kingdom of Snow again. Where else could it have found a snow petticoat? But our hailstone had more than two petticoats. And this means that it had been flying up and down, putting on a new petticoat at each stop: a snow one upstairs and an ice one on the floor below.



How could it go back upstairs once it had found itself downstairs? Surely, it had no wings?

Well, it was tossed upwards by the wind, the only thing powerful enough to lift it up.

Now you know the hailstone's story, and you know it because you found out what it was wearing. It took a long time for it to dress up and get ready to go visiting, but when it finally arrived, all its lovely petticoats started melting. However, it still had enough time to tell you where it had been and what it had seen.

You found out that there are snow-clouds above the rain-clouds. Once you thought that the wind could only blow from the left or the right, from the front or from behind, but now you know that there's another wind that blows upwards, like a fountain. This was the wind that wouldn't let the hailstone fall to earth while it was getting dressed to go out.

The people who fly in the clouds and above them have to know all about the different kinds of clouds and winds. If you want to be a flyer, you'll have to study the science of air and water, so that your aeroplane won't be battered by the wind during a storm, or be covered with a sheet of ice in a cold cloud, so you'll be able to guide your plane bravely and confidently along the airways.

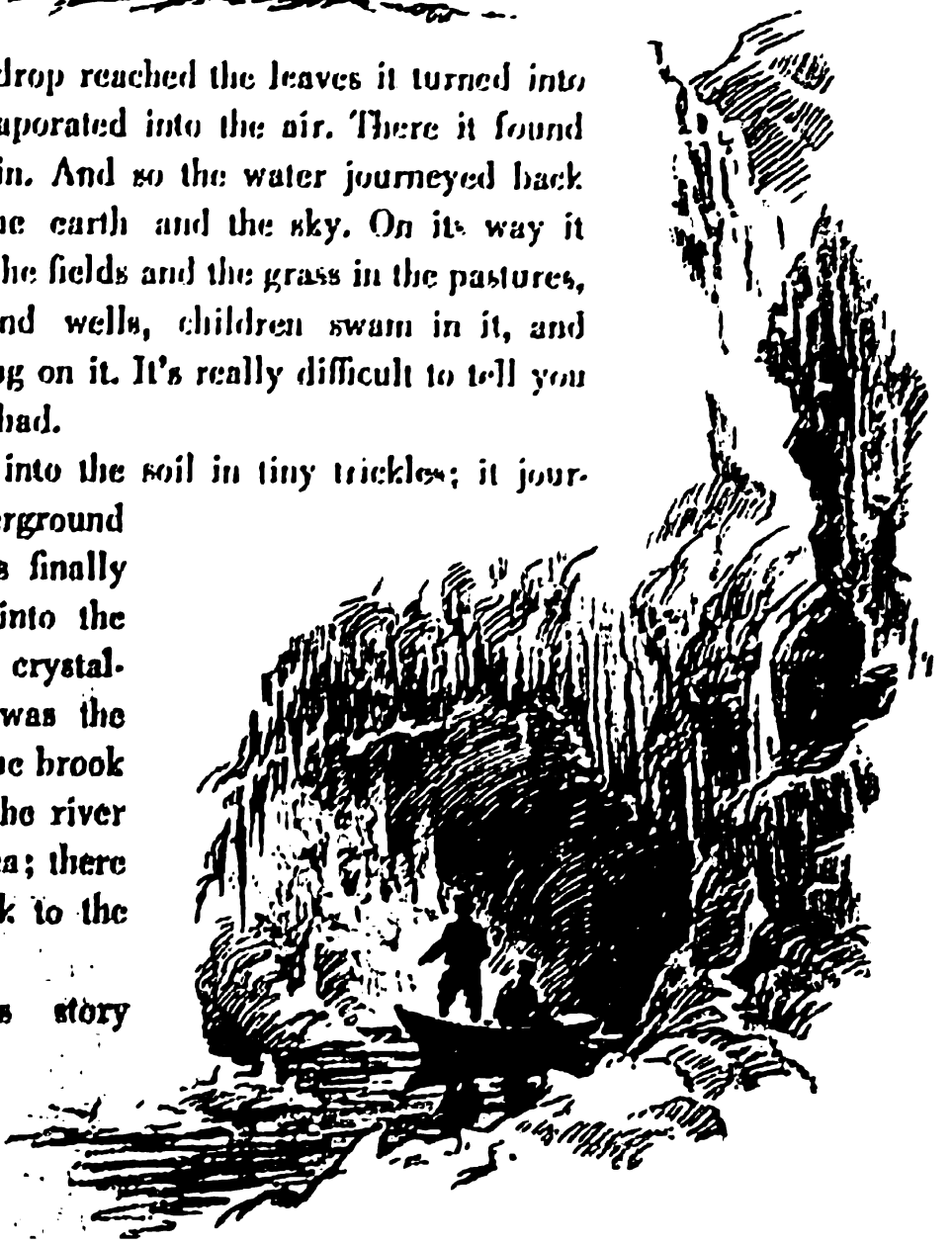
JOURNEY'S END

The raindrop fell to earth once more. It seeped through the ground and was caught there by the roots of a tall birch-tree. The drop reached the leaves through the tree trunk and brought them the minerals which the roots had taken from the soil. No plant can live without these mine-

rals. When the little drop reached the leaves it turned into vapour again and evaporated into the air. There it found itself in a cloud again. And so the water journeyed back and forth between the earth and the sky. On its way it watered the wheat in the fields and the grass in the pastures, it filled the ponds and wells, children swam in it, and grown-ups went rowing on it. It's really difficult to tell you all the adventures it had.

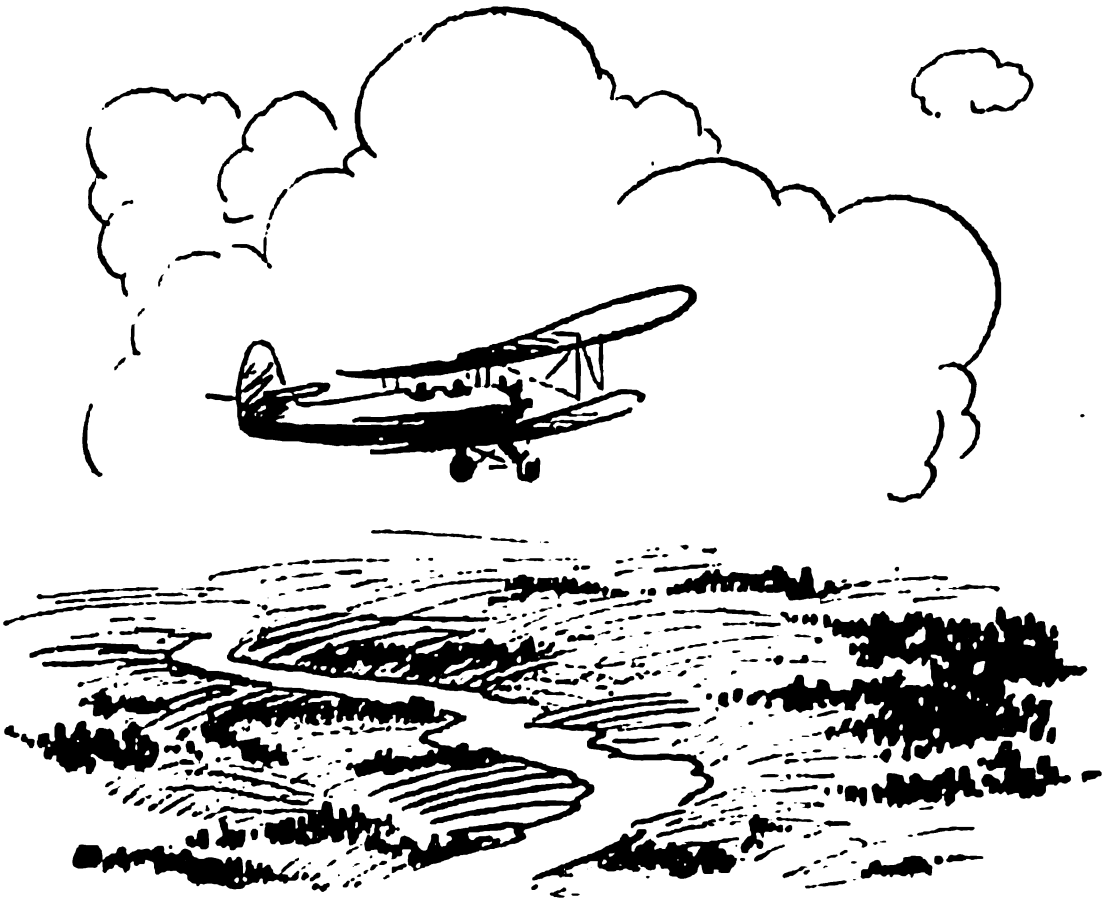
The water seeped into the soil in tiny trickles; it journeyed far in the underground darkness until it was finally able to burst forth into the light again as an icy, crystal-clear spring which was the source of a brook. The brook flowed into a river; the river flowed down to the sea; there the wind took it back to the shore. . . .

Where does this story end?



That's just the point, this is a story without an end. Year in, year out, from century to century, the water journeys in a circle: from the ocean to the land, from the land back into the ocean. By knowing all the ways and paths the water travels, we learn how to control it better and how to make it our ally instead of our enemy, for if the water is permitted to have its own way, it can be very destructive. During the spring floods it can flood a city if its path is not blocked by an earthen dike. It can sweep away a bridge, if the people who built the bridge did not know the water's strength. So you see, engineers must also know nature's alphabet.

FORESTS AND RIVERS, DESERTS AND STEPPES



HOW THE RIVER CHANGED ITS SHAPE

Once upon a time, a little city stood on the bank of a little river. River-boats and barges laden with goods docked near the city. Women went down the steep green bank to the river for water, carrying pails on a yoke over their shoulders.

As time passed the city spread out, incorporating the surrounding villages. Houses went up along the roads leading to the city, and the roads gradually became city streets. There were even a few stone houses among the wooden ones.

With each passing century the city grew richer and more beautiful. The houses became taller, there were more people living in them.

The city kept growing, but the river never changed, until, finally, it became too small for the city, just as last year's shirt is too small for you now. Large ships could never come near the city, for the river was too shallow, and you know that a little river-boat can't carry so very much. Apart from that, there wasn't enough water for the city.

The people became worried. They thought: our city is large and rich, it's the most important city in the whole country, and it should stand on the bank of a mighty river, so that ships from all the four corners of the earth would be able to dock here. Instead, it's on the bank of a little river, and before you know it, the city will drink the river dry!

There was a wide and mighty river in that country. It was so wide and deep that the biggest ships could easily sail down it. The big river had only one fault: it was so very far away from the capital city.

The people then began thinking of ways to bring the big river to the capital. It was quite simple to dream about it, but not simple at all to make these dreams come true. Great forests and large hills lay between the capital and the river. It's easy to make water flow downhill, but how could it ever be made to flow uphill? The people of that country were not discouraged by such problems, because they had solved many more difficult ones already, and had really worked miracles. They set to work and before long a deep river-bed was dug between the big river and the big city. Where hills stood in the way, the water climbed up them along a giant staircase, going higher and higher from step to step. Big ships came up the staircase to the city too. It's a long way from the capital to the sea-shore, but even so, ships from five seas now dock there.

What country was this story about? It was about the Soviet Union.

If you want to see how the waters of the mighty Volga reach the capital, you'll have to take a trolley-bus from Moscow to the river port called Khimki. The lindens grow in two straight rows on Gorky Street,

but by the time you reach Leningrad Highway, on the outskirts of the city, they grow in several rows on each side of the street. And then the trolley-bus conductor cries out, "Terminus." You can't see the river yet, but everything here reminds you of water.

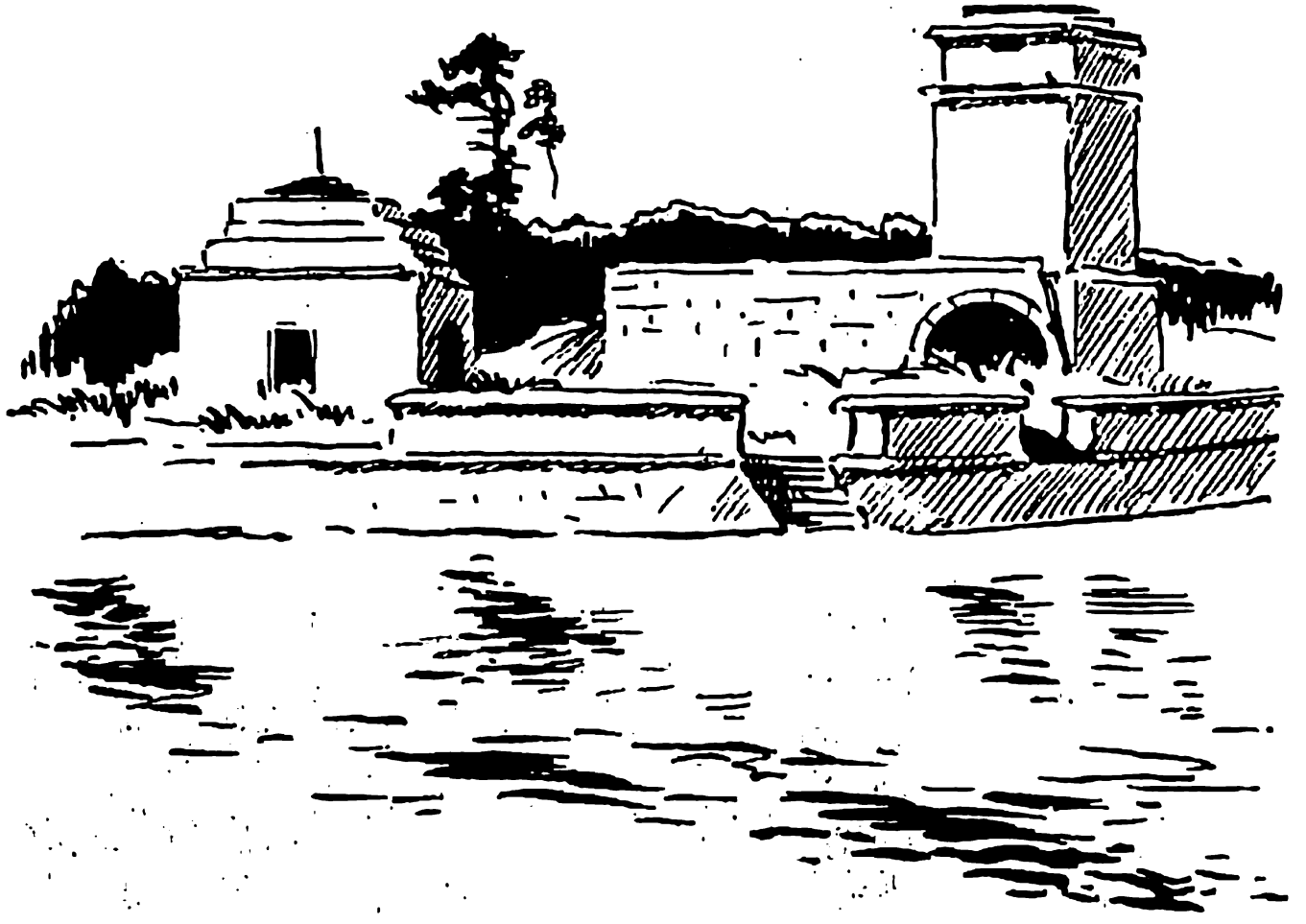
The fence around the park is decorated with anchors and anchor chains, and there's a high pedestal at the entrance, with a statue of a young girl holding a sailing-boat over her head. A wide avenue leads past the flower-beds to a building which looks like a large white boat; there are galleries all around the building that look like decks; a four-cornered tower with a balcony around it rises in the middle of the structure, just like the bridge of a ship; and for a mast there is a tall spire, topped by a five-cornered gold star.

You have often seen ordinary railway stations, but you've never seen a river station before. There are granite embankments called moorages instead of platforms; there is water and sea-gulls instead of rails and crossties; there are white steamboats and diesel ships instead of locomotives and waggons.

While we're waiting for a boat, let's go and see the freight port, it's only a short walk from the station. What's on that wide asphalt square? Shiny new automobiles, which have just arrived; piles of automobile tires and sacks of wheat stacked high; mountains of sparkling white salt. These very different products are all called cargo.

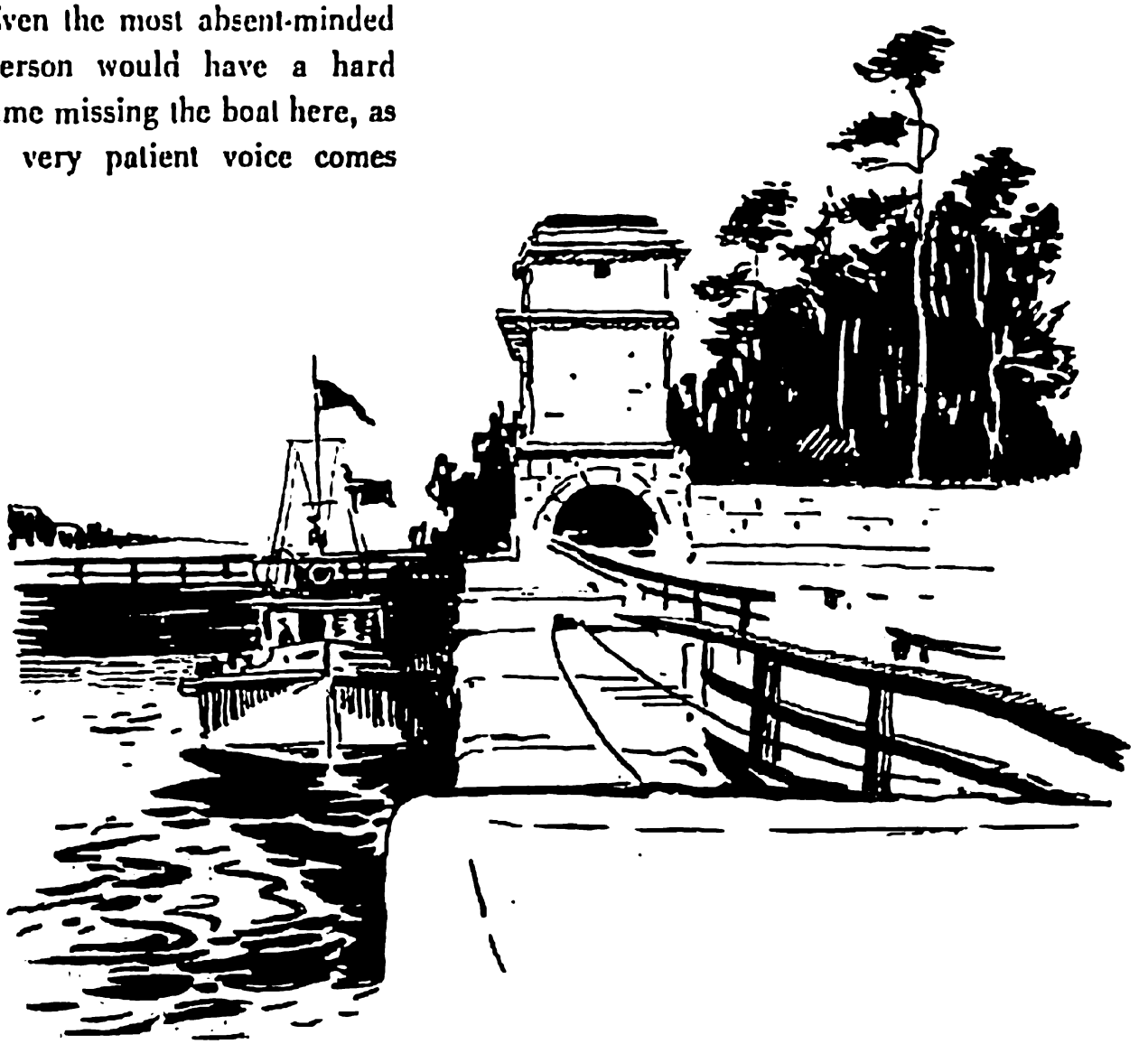
In the old days stevedores used to carry the cargo off boats and barges. They were tall, broad-shouldered men with tremendous muscles, and if a heavy great crate had to be taken ashore, the stevedore would bend over and let someone else hoist it on to his back. He had to be skilful as well as strong, or else he would break his back and fall over dead on the spot. He would trot down the gangway as fast as he could, in order to reach the dock and get rid of his burden. There were no stevedores over forty years old, because their work was so hard that no one would endure it long.

There are steel stevedores on the docks to help the port workers now. These stevedores don't even know the word "tired." There are giants there that can whisk a car off a ship's deck and set it on the shore without getting tired at all. Look at the steel giants standing in a row on the shore! From afar it seems as if long-necked grey monsters are standing on their hind legs. The would-be monsters are really cable cranes. One of them has started out and is slowly moving down the track. The crane-operator is high up in a glass cabin. The crane rolls over to the cargo boat and comes to a stand-still. Its long neck, called the jib arm, turns towards the boat. In another second a light grey *Pobeda* is hanging high over the water. This car has never yet driven down streets or roads, but it has already sailed from Gorky to Moscow and flown from the freighter to the dock!



People have other helpers in the port, too. There are midget cranes on the ship's decks that hoist one crate after the other out of the hold; sacks slide down chutes from the boat to the dock; a red vehicle with two steel hands in front that looks like a tractor scoots up and down the embankment. It rolls over to a board with a pile of automobile tires on it, lifts the board up in its steel arms and carries it off to a warehouse, where a big stack of tires is already waiting. The steel stevedore lifts its cargo still higher and places it on top of the whole stack.

However, it's time we returned to the station, or we'll miss the boat. Even the most absent-minded person would have a hard time missing the boat here, as a very patient voice comes



through the loud speaker over and over again, saying, "Attention, please! Passengers for the *Levanevsky* are requested to come aboard."

The passengers have to cross over a little wooden bridge called a gangway in order to get from the granite embankment to the ship. A noisy, lively crowd of people settles down in the deck chairs. There's a long, sharp whistle, as if the ship were saying, "Good-bye, Moscow!" and the embankment seems to move slowly away. The strip of water between the ship and the landing-stage widens with every passing second; two waves flow away to the shore in two diverging lines as the ship's prow cuts through the water.

There are sign-posts on the highways to help motorists find their way. On the waterway there are two rows of red and white buoys, one to the left and one to the right. A buoy is an empty iron barrel riding at anchor. Each buoy has its own electric lamp which is lit up at night, creating a chain of light over the water and making it quite impossible to get lost, for the lights are just like lighthouses.

The Moscow Canal is an artificial river eighty miles long.

A river usually flows downhill and doesn't know how to flow uphill at all. The artificial river rises 117 feet in its journey from the Volga to Moscow, and that's why the great water staircase had to be built. When a ship going to Moscow from a city on the Volga comes to the first step of the stairway, it finds the canal blocked by gates. The huge, heavy gates swing open as if by magic, and the ship enters a long, wide corridor called a lock. The walls of the lock tower high above the sides of the ship. Then the gates close and the water level in the lock starts rising rapidly, lifting the ship as it rises. When the ship has reached the top, other gates open at the far end and it sails out into the canal again.

This is how the water rises from step to step up this strange stairway. The steps are giant ones: each one is 26 feet high.

How do they make the water climb up against every law of nature?

There are pumping stations next to the lock which make this possible. Powerful pumps force the canal water into the lock through huge pipes.

What about the boats coming from Moscow? How can they go down the water-steps? When the ship enters the lock, the water there is high. It is gradually let out into the canal, its level falls lower and lower, and if you stood on deck you would think that the walls on both sides of the boat were getting higher and higher. Actually, though, it's the boat that is going down with the water.

What is it that opens and closes the heavy gates, that orders the water to rise or fall inside the lock? It's all done by the person who works in the tall tower on the lock. In front of him on a marble wall are instruments with dials just like clocks. A slanted table covered with knobs and levers runs along the entire wall. Each lever has its own job to do. If you swing one over, the lock gates open; if you swing another, the pumps start working. The man in the tower is like a magician. He controls the life of the lock. He can give eight hundred and fifty different orders to the machines, just by turning the knobs and levers!

Never before in the history of the world was there a canal like this. Cars and trams run under it through tunnels. Trains rumble over it on railroad bridges slung across the water. Not far from the Volga the canal runs across the Sestra River. In order to give the canal the right of way, the river had to be trapped inside a huge pipe. When ships pass this spot the passengers can see the Sestra bursting out from under the canal into its own river-bed.

It took a lot of hard work to build the canal and all the dams, reservoirs, locks, pumping stations, lighthouses, piers, and passenger stations along the way. A dam had to be built near Moscow in order to make the waters of the Volga flow up to the Kremlin walls. The great river overflowed and formed an artificial lake of such size that it was called the "Moscow Sea." Now ships sail over the flooded tree tops.

The canal brings twelve times as much water to Moscow as the Moskva River used to, and although it's some 30 miles longer than the Panama Canal, it only took four years and eight months to build it.

When you look at the flat surface of the water from a ship's deck and see the mirrored reflections of the green banks, it's very hard to imagine what things were like here when it was still a construction site. Mighty excavators worked from dawn to dusk on the slopes of the canal bed; locomotives pulling trainloads of earth roared by; trucks and people swarmed over the still dry canal bed.

Day after day, in summer's heat and winter's cold, the builders moved stubbornly onward, conquering every obstacle in their path: the hills, the ravines, and the bogs.

A row of hills blocked their way not far from Moscow, but the builders didn't retreat or by-pass them. They cut through the hills, and the gap they made was so deep that a five-storey house could have fitted into it.

The Moscow Canal is only one of the many great projects the Soviet people are working on.

New dams and hydro-power stations are going up all along the Volga, the largest ones are being built near the cities of Kuibyshev and Stalingrad. They will supply electric current to Moscow, to cities on the Volga, and collective farms hundreds of miles away.

The force of the Volga's waters will give power to electric trains, factory machinery, and to electric tractors in the fields.

The dam will make the water rise high and will transform the river into a chain of wide lakes. The captains of boats won't have to worry about the sand-banks which used to trap their craft, and the passengers on board the large Volga river-boats will think they're at sea. On windy days rows of high waves will cover the surface of the reservoir lakes; and so the boats that sail on them must be able to weather big storms. At night the ships' way will be lighted by the bright beams of the light-

houses. In winter ice-breakers will steam across the reservoirs, mounting on to the ice with their prows and breaking through it with their weight, thus clearing the way for the ships. In the hot days of summer Volga water from the lake-reservoirs will flow along irrigation canals on to the fields.

On July 27, 1952, all the Soviet Union celebrated the opening of the Lenin Volga-Don Canal. It had connected two mighty rivers, the Volga and the Don, and ships now sail from Moscow to Rostov-on-Don along a waterway over 2,000 miles long.

A ship leaves the Moscow Canal and goes down the Volga to the city of Gorky; it passes the two hydro-power stations under construction at Kuibyshev and Stalingrad, then it turns westward and continues along the Volga-Don Canal. It rises up a staircase of locks until it reaches the watershed between the Volga and the Don; then it descends to the new Tsimlyanskaya Sea, which appeared when a dam was built across the Don near Tsimlyanskaya village. From there it's not far to Rostov.

Once the ship has reached Rostov, it can continue on its way to Batumi, Sochi, and Odessa which are on the coast of the Black Sea.

Thus, Moscow became a port, a port of five seas. You could first travel from the Soviet capital to the Baltic, the White Sea, and the Caspian by water; when the Volga-Don Canal was open to navigation the new waterway connected Moscow with the Black Sea and the Sea of Azov.

It's not easy to dam wide rivers and create artificial reservoirs as big as seas, to build waterways like the Volga-Don Canal, but Soviet builders have everything necessary for these monumental projects: knowledge, experience, and powerful machinery to help them.

Take a walking excavator, for instance. It's as tall as a five-storey building and its scoop is so big that a car can be driven right into it. The steel arm in which the excavator holds the scoop is 70 yards long, and what big feet the monster has! There are huge hollow girders on its feet instead of soles. Although the steel monster can't walk very fast, it makes

up for it by taking six-feet-long steps at a time. The man at the wheel is no ordinary driver, he's an engineer. There are many buttons on the dash-board in front of him. By pressing these buttons he can make the walking giant scoop up 490 cubic feet of earth and toss the load 164 yards away.

There are also huge suction dredges at work on dam construction sites. In 24 hours one of these machines can dig up enough earth to fill a thousand railway waggons. If they were to dig with ordinary spades and carry the earth away in carts, they would need thirty-five thousand labourers and fifteen thousand horses to replace one suction dredge.

Never before were there machines like these. And no wonder, for never before did people undertake such projects and change the face of their country so quickly.

WHO RULES THE STEPPE!

Once, the earth, the water, and the wind had an argument. They couldn't agree as to who was the master of the steppe. The earth said, "I'm the mistress here. If it weren't for me, there wouldn't be a single stalk or blade of grass in the steppe. The people all call me 'mother' and 'benefactress.' Look around: as far as the eye can see there's nothing but earth right up to the edge of the sky."

When the water heard this it poured torrents of rain down on the earth in protest. "No," it said, "I'm the master of the steppe. Could you, Earth, nurture a single blade of grass without my help? Everyone needs me—grass, animals, people. Nothing can live without me. I can do anything I want to with you, Earth! If I get angry with you, I can even pack you off into the sea!" No sooner had the water finished speaking,

than it rushed into the fields in little streams. It started making deep ditches and ravines in the steppe and washed away the topsoil. The water gushed down the ravines, carrying the earth away to the rivers, and from the rivers into the sea. Sterile sand and clay were left where there had once been fertile black earth.

"Look how mighty I am!" said the water. "I can wash all the soil off the fields if I want to. I rule over everything in the steppe."

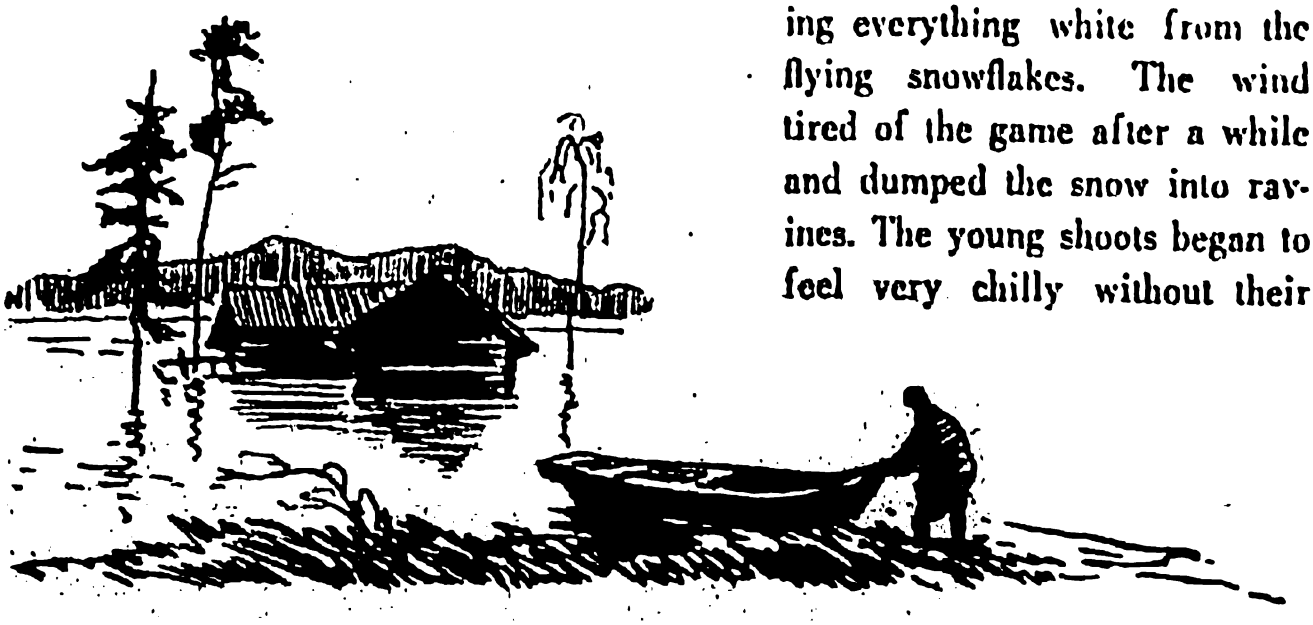
When the wind heard this, it started blowing as hard as it could.

"I'll show you who's master here!" it said. "I race up and down the steppe day and night, from south to north and from east to west. I've enough strength to blow both the earth and the water up to the sky and carry them off!"

As soon as the wind had said this, it howled across the earth which was still wet from the downpour. The wind dried up the puddles, absorbed all the water, and whisked it away. The water gathered in great clouds in the sky, but they started moving away until they had completely disappeared from sight. The earth became very dry. Its young shoots of wheat and rye needed watering, but there was nothing to water them with, because the wind had blown the water away.

The wind started blustering still harder and was getting ready to blow the soil away, too. The shoots of wheat and rye clung to the earth with their roots and didn't want to let go, but they couldn't keep the soil from being blown away, because it had become as dry as dust. The wind blew the dust from under the roots and sent it skyward in huge black dust-clouds. Everything became so dark that even the sun was blotted out by the dust-storm. The wind amused itself a while longer with the soil and then tossed it away, but it didn't throw it back where it had taken it. When the soil fell down to earth it landed on green fields and smothered the young plants, choking them to death.

How much trouble the wind had caused! It had robbed the wheat and rye of soil in one place and smothered them with it in another! The



time for harvesting was drawing near, but there was nothing to harvest: the corn had been destroyed by the black dust-storm.

The people sowed more corn, and by the autumn the young shoots made the fields bright green once more. Winter came. The water turned to snow, covering the fields with a white quilt.

"I'll protect the wheat," it said. "My snow-blanket will keep it warm all the winter. In the spring I'll change back into water and let the ears drink to their heart's content."

When the wind heard this it tore across the fields and ripped the snow-blanket off the earth. It let the white fluff escape and chased it over the ground, making everything white from the flying snowflakes. The wind tired of the game after a while and dumped the snow into ravines. The young shoots began to feel very chilly without their

warm quilt, and to make matters worse, the wind then brought a frost from the north and nearly killed the winter wheat altogether. Luckily, spring was just around the corner.

The sun warmed the fields and revived the wheat and rye. They started sprouting up and were just getting ready to enjoy a long drink of water, when they were cheated out of their share again. Remember how the wind had dumped all the snow in the ravines during the winter? Well, the snow turned into water and rushed away down into the river, leaving the fields dry.

The rivers were flooded with it, though, and they really went wild. They started washing away bridges, breaking through dams, and pouring into the cities and villages. All the lowlands were under water: it had risen as high as the ground-floor windows, and each tree looked as if it were growing straight out of the water.

The fields were on high ground and the soil was as dry as powder. The hot wind from the desert scorched the corn and turned the fields yellow. The fields were a mass of dry straw and nothing else. Occasionally one found a grain or two in these ears. The wind was still dissatisfied. It began to wave the ears back and forth, shaking the grain out. Harvest time came round again, but there was no grain to harvest.

So the people started thinking of ways to take matters into their own hands. They ploughed and sowed, but the idle wind kept robbing them of earth and water. They were determined to put an end to this state of affairs and called the forest to their aid.

The forest was an old friend of theirs. It gave them logs for their houses and fire-wood for their stoves. They built their boats of wood and made wooden cradles for their children, and when their children were old enough to go out alone, they would head for the woods to gather berries and mushrooms. The forest was indeed a faithful friend. The most important thing, however, was that it knew how to handle both the wind and the water. However much the wind raced towards the edge

of the forest, tearing through the leaves and branches, the forest always tamed it in the end.

A strong wind can blow you over out in the open steppe, but it's quiet and still in a forest. The wind is way up in the highest tree tops, swaying them from side to side.

The forest had a way with the water too. It never let the snow melt quickly and drain off into the streams. In the springtime every tree trunk shaded the snow from the sun. The trunk would warm up and warm the snow around. As melted snow began trickling across the ground in little streams, the forest would say, "Stop!"

There's a carpet of dry leaves and pine needles in the forest under the trees, just like a thick furry door-mat. It absorbs the snow-water like a sponge, stopping it on its way to the river. Then, instead of rushing down the slopes, the water seeps into the earth right to the tree roots; it quenches the trees' thirst and feeds the forest springs which flow into the rivers. That's why rivers in forest regions never dry up—even in the hottest weather.

The people knew all this and decided to go to the forest for help. They wanted to stop the steppe winds with mighty regiments of oaks, maples, and pines, and post patrols of bushes and trees along the ravines and rivers; they wanted to partition off the ravines and prevent the snow-water from escaping into the sea. And that's exactly what they did.

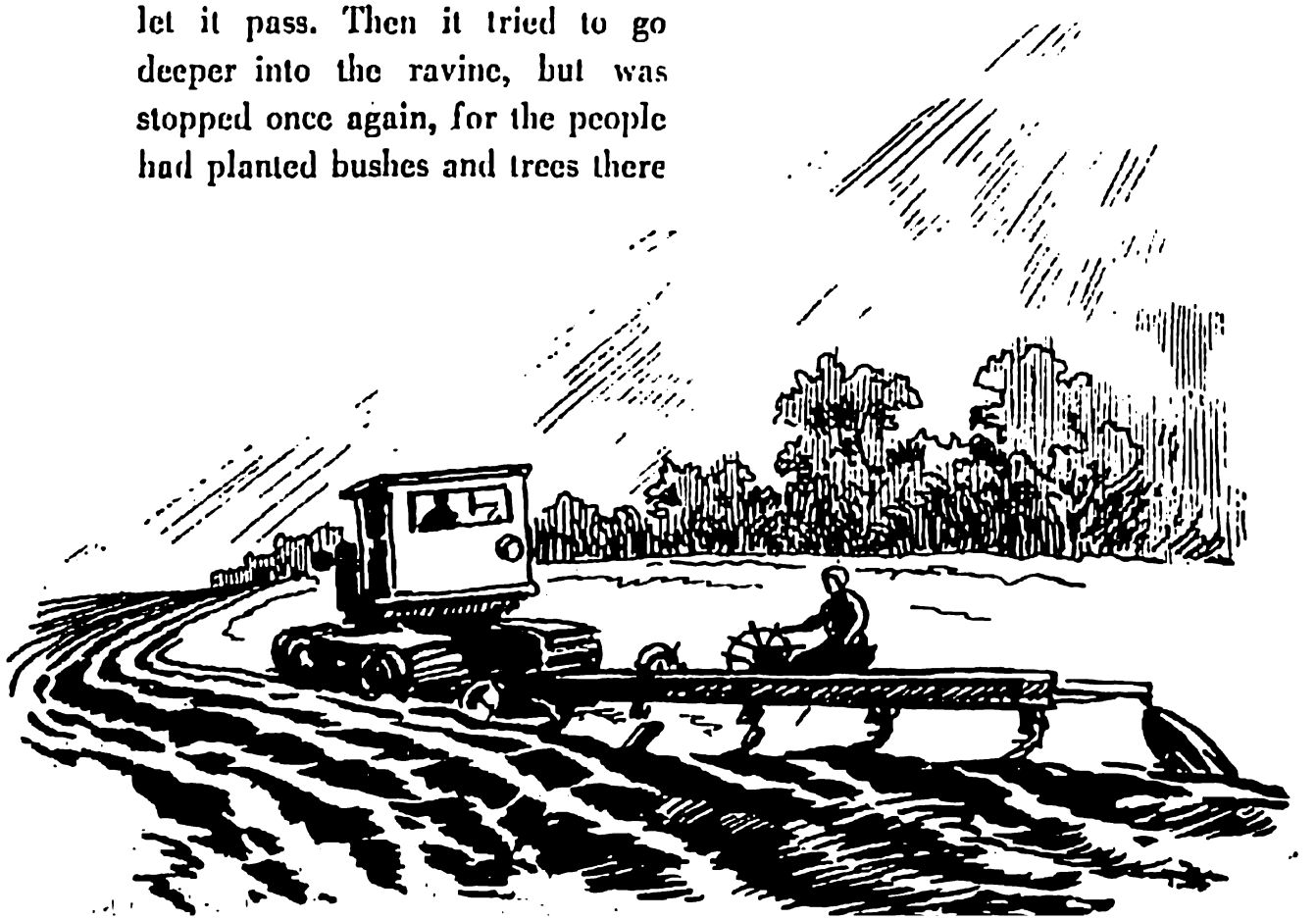
One day the wind decided to try its old tricks again and blow the soil off from the plant roots, burn the ears with hot air, and shake the grain to the ground.

It was just about to blow a mighty burst when it found itself face to face with an army of great oaks! It was all it could do to blow through the first squad; but there was a second squad behind the first and a third and a fourth after that. The wind was completely exhausted and could blow no more, but it wouldn't give in and still threatened, "You haven't

seen the last of me yet! Since I wasn't able to kill the crops with heat, I'll finish them off with a frost."

When winter came, the wind tried to attack the fields again, but this time it sneaked up from the south instead of from the east, as it had done before. It tried to blow the snow-blanket off the fields, but all it got for its trouble was a dent from its great collision with the wall of trees! The people had foreseen everything and had planted trees on all four sides of the fields. The wind was beaten and it wailed, "They've finally tricked me."

The people tricked the water as well. When it decided to run off the fields and take the topsoil along with it, it suddenly had to change its plans, for the forest belt lay right across its path. The forest carpets absorbed the water and wouldn't let it pass. Then it tried to go deeper into the ravine, but was stopped once again, for the people had planted bushes and trees there



which were gripping the soil with their roots and wouldn't let the water wash them away. The water saw that the ravine was no place for it and planned to escape to the river, and from there to the sea. But the people had partitioned off the ravine and wouldn't let the water out. It had no other choice but to become a quiet pond in the ravine. Then the people said, "Don't be lazy. You may as well work while you're at it, so off with you to the kitchen gardens along this ditch, and water the cucumbers and cabbages."

They found some work for the wind too, and set it to turning the arms of a wind turbine and pumping the water.

The people defended the earth from all its enemies and it, in turn, began to give them twice as much grain as it had before, even in the best of times. So the earth and the water and the wind had to agree that man was the master of the steppe. Well, if he was master, then they'd have to obey him and serve him faithfully.

You may ask which steppe is the one where the people have planted forests, blocked off the ravines, tamed the rivers and black dust-storms, and who the giants are who have conquered the winds, the blizzards, and the waters. The steppe is in the Soviet Union and the giants are just ordinary Soviet people—workers, collective farmers, engineers, and scientists.

They are transforming the earth according to the laws of science, not only in the southern steppes, but in the forest regions of the north as well.

There's not enough water in the south and the fields there have to be irrigated. But in the north it rains very often and there's too much water. The water collects in many places and the land becomes swampy. When the swamps are drained, grain and flax are planted on the reclaimed land. The soil in the south is fertile and is called black earth. But there are many regions in the north where the soil can't supply the necessary nourishment to the plants, and that's why the wheat, rye, and clover

starve there. In order to transform poor soil into rich soil, the collective farmers spread fertilizer over the ground, or dig furrows and throw fertilizer into the furrows. This is done by machines, to make the work go faster. The fertilizer is chosen to suit the particular needs of the soil. Some kinds of soil need lime, but other kinds would be ruined if lime were added to them.

Chemical factories supply the collective farmers with wonderful fertilizers. Trains pull away from the factories in never-ending streams, carrying very special flour and magic grain. No one will ever eat them, because they're intended for plants and will nourish the wheat, the potatoes, and the clover. Thanks to the wonderful flour and grain, the earth can produce twice or three times as much as it used to. And this is how man became the master in our country.

THE STORY OF THE OLD SCIENTIST AND THE WICKED DRY WIND

Many years ago, when your grandfather was younger than you are now, there lived a great Russian scientist. He looked old because he had a long grey beard, but his step was firm and his eyes were young and alert. His eyes could see what other people's couldn't.

The scientist travelled across the country on foot and on horseback, studying the forests, and steppes, and mountains, but he always kept returning to the treeless steppes. Tall grass or waving wheat stretch as far as the eye can see. In summertime the scientist roamed among the dried-up stalks and wondered, "Why is it that there's always more than enough water here in spring, but now, when it's needed more than ever, there's none at all?

"Every spring the steppe is full of streams and brooks. As soon as the last snow has melted, the land is covered with flowers, one sort springing up after the other, changing the steppe carpet from violet to light blue, from blue to scarlet.

"In summer it's very drab—the heat burns up the grass, the ears wither in the fields from lack of water, and the whole steppe becomes brown. The wicked dry desert wind arrives about this time, burning the wheat and curling up the leaves on the bushes with its fiery breath. There is hunger in the country then, for it's the steppe that feeds so many people with its grain."

These were the thoughts the scientist had as he wandered about the steppe. He loved his country and wanted to rid it of drought and famine, but to do this he first had to discover the origin of the drought.

The scientist asked the old men in the villages whether the steppe had always been like that, and the answer he got was always the same:

"Yes, always. In our grandfathers' time and in our great-grandfathers' time, too."

The old scientist only shook his head. He knew there was something wrong somewhere. Everything changes in this world. There must have been a time when the steppe was different, too. But what was it like then? To find the answer to this question he'd have to learn how to stride across the years and centuries just as he could across the land. The scientist was no fairy-tale magician, and he knew it would be much harder to travel a thousand years backwards along the road of time than to cover a distance of a thousand miles on land. Science demanded that he learn how, and he did.

He examined everything in the steppe attentively: the animals and birds, the ravines and the rivers, the flowers and the grasses. He noticed every little abandoned and filled-in marmot burrow; he explored the chains of burial-mounds. The scientist knew that if there was a green burial-mound in the open steppe, it meant that a thousand years before

the steppe had been there too. When the steppe-dwellers of long ago buried their leaders, they used to pile a high mound on the grave to make it visible from afar. There are never any mounds in the forests, because there was no sense piling them up in a place where they could never be seen because of the trees.

The remains of rodents' burrows proved that the steppe had been there in ancient times too.

"I still don't believe that the steppe was always bare and treeless," the scientist thought. "Antlers and long curved mammoth tusks have often been found deep in the earth here, but deer live in forests, and the great shaggy mammoths that looked like giant elephants never lived in the open steppe either. That could only mean that there were forest regions in the steppe long before the burial-mounds had been erected. Some fragments of these prehistoric forests have survived as islands of trees lost in the sea of grass."

The scientist walked along the high, steep bank of a little stream called Waterless and was amazed at what he saw. The narrow stream flowed down a ditch far beneath the banks of its bed but it had made itself a wide, deep road in the steppe; it was very, very far from one bank to the other! The little Waterless River looked quite out of place in its wide river-bed. The scientist picked up pebbles which were as smooth and as round as little pieces of soap. Who had polished them so well? It must have been the river, as there was no one else who could have done such a good job. But the little river was far below. How did the pebbles get so high up on the bank? Apparently, the river had been much higher at one time, and that must have been long before the river got its name, for would people ever call a deep, wide river "Waterless"?

The Waterless River has many sisters in the steppe, and they are all alike. They are called "Dry Orzhitsa," "Dry Lipyanka," "Dry Goliva," "Flownot," "Drawnot," and so on. They are called "Dry" because they dry up in summer; "Flownot," because there's not enough water to

make the river move; and "Drawnot," because it doesn't even have a current, so that a piece of wood will only rock quietly on its surface.

The names of the rivers, the mounds, the abandoned, filled-in burrows, the mammoth tusks, the pebbles on the river-banks, and many other signs all helped the scientist to find out what the steppe had been like before, because he saw what other people never noticed.

What did he see as he moved backwards along the centuries into the past? He saw that once upon a time the steppe had been entirely different. Mighty forests had grown in places where the scientist rarely saw a single tree. The rivers had once been deep; the unploughed steppes had been covered with a thick matting of old, rotted grass; and new grass would come up through the matting every spring. There were no droughts in the steppe then. The forests that grew on high ground between the rivers prevented the snow from melting quickly and running off into the rivers. The snow-water kept seeping into the soil and the heavy grass matting absorbed the water and stored it up till the summer came. That's why the grass once grew four feet tall in the steppe.

But people had chopped down most of the trees, and there was nothing left to shield the snow from the sun's warm rays. People had ploughed up the land and destroyed the thick grass matting. Then the snow melted faster, and the water drained off into the rivers, and from there to the sea, where there was quite enough water already. The brooks were lively, but the people were glum, because the brooks and streams were washing the soil away. They were stealing unashamedly, pulling away clumps

of soil in broad daylight and muddying the rivers. The latter worked hard and dragged as much mud as they could into the sea. This was all very good for the seaweed, but the grass and wheat that grew on dry land had a hard struggle, because they were being deprived of their food.

The stream ran along the furrows and ruts and made them deeper and deeper, wider and wider. Before long a furrow would turn into a deep gully and the gully into a ravine. It kept on growing wider and its banks were becoming much steeper. All summer long the ravine drained the water from the fields, even though the wheat and rye were already very thirsty.

This is what the scientist saw as he travelled backwards on the road of time.

The scientist knew how to look into the future too. He knew that a time would come when the people in his country would become the wise masters of the land. They would come to understand that the forest in the steppe was their ally and that the dry wind was their enemy. Therefore, to prevent the dry wind from reaching the fields, its path would have to be blocked by forest walls, or forest belts, as we call them. Instead of chopping down the last remaining trees in the steppe, others should be planted in areas where there were none. Then the dry wind would blow in from the desert and come up against a wide wall of oaks, maples and pines. When it tried to tear through the wall, the branches would break it into little streams of air.

It's always cool and damp in a forest, and a hot wind caught there will cool off and become moist. Forest walls like this will protect the steppe from its enemy the dry wind. However, forest walls alone would not be enough, as the ravines would also have to be dammed up to prevent the water from draining off the steppe. The ponds which would then appear in the ravines would supply the fields and vegetable gardens with water. So thought the scientist as he roamed the steppes.

All this happened about sixty years ago, and it was just at this time that the country was plagued by a terrible drought. The grain burnt up from the heat, and the peasants had nothing at all to eat.

People started baking bread from a weed called goose-foot. They'd boil it in water and add a little flour to the mush. Each handful of flour was precious, so they added earth and ashes to make more dough. Then they baked the mixture. Even the chickens died from it. Very often people who ate this bread became ill and died too.

The old scientist couldn't be indifferent to the suffering of the people, to the exhausted and hungry peasants that crowded the cities, begging for food. He knew what had to be done to prevent such famine from ever occurring again.

He wrote a book entitled *Our Steppe, Before and Now*, in which he described the steppe as it had once been, as it was at present, and as it should be in the future. In those days there was still a tsar in Russia, and most of the land belonged to the landlords. Every landlord did exactly as he pleased on his land. If he needed more money he would have the trees on his land chopped down and would sell them for logs, and no one could stop him from doing it.

The land was ploughed up and sown to grain year after year, and this was not at all good, for it never gave the soil a chance to rest. The fields were ploughed and re-ploughed until all the lumps in the earth had been broken down and the soil had turned into dust. The lumps in the soil are very important, for they store up moisture. The tiny bacteria do their work of changing dead stalks and roots into plant food much quicker in lumpy soil. In order to save the lumps in the earth, perennial grasses should be planted from time to time. They change the fields into grasslands for a while and give the earth a chance to recover and become lumpy again, and then grain can be planted once more. But this system was not very profitable for the landlords. They were much more interested in planting grain year in and year out, and selling it on the market.

The peasants were illiterate and didn't know that there was a science about the soil; and then, even if they had found out about its existence, there wasn't much they could have done on their tiny strips of land. Their only thought was how to survive and not die of hunger.

The old scientist wrote that negligent masters would only harm the country, and that it would be impossible to avoid another famine if science were disregarded completely. He told the landlords that it was criminal for them to think only of their own profits and to farm in a way that was unscientific and not in the interests of the people.

Perhaps, if this had taken place at some other time, no one would have paid any attention to the words of the old scientist, but it happened at a time when there was famine everywhere, and the tsar's ministers were very worried. So they gave the scientist some land on which he could carry out his experiments. It was located in the steppe, between two big rivers, the Volga and the Don. This part of the country was called the Stone Steppe and the hot dry wind was a frequent visitor

there. The old man moved into a little thatched hut in the Stone Steppe, which has been preserved to this day.

Work was started. Trees were planted according to the scientist's directions and ponds created in the ravines. The trees were planted in rows, and square fields were formed among the rows of trees.

No sooner had work begun on the project than it came to a halt. In tsarist Russia some officials were in charge of the forests and others were in charge of the fields, and they could never agree about anything.

The old scientist kept trying to explain things to them. He said, "I'm planting rows of trees in order to protect the fields from the dry wind. Let me have enough money for my experiments to make it possible to plough and sow the land between the forest belts in the Stone Steppe."

But some officials said, "We're not at all concerned with the fields, we're in charge of the forests."

The other officials turned a deaf ear too, and said, "We're not at all concerned with the forests, we're in charge of the fields."

The years slipped by, but the officials still couldn't agree. The old scientist fell ill, partly from grief and from the hard struggle he was having, trying to defend his project. The whole matter was forgotten completely after his death.

Nowadays, things have changed in the Stone Steppe. If you look down at the land from an aeroplane, the first things you notice are the dark forest belts and the bright green squares of the fields among them. The huge ravines have vanished and been replaced by ponds, surrounded by shady trees and bushes. Flocks of geese swim in the ponds. The burnt-down grass has vanished and been replaced by fields of swaying wheat and thousands of golden sunflowers. Yellow cornfields alternate with the green squares of land sown to perennial grasses.

Everything is done scientifically. The dry wind has been banished forever and the fields and gardens produce big crops of wheat, rye, water-melons, and cucumbers even in the driest summers!

You'd see all this if you had a chance to fly over the Stone Steppe and many other regions too, and then you'd probably remember Vasily Dokuchayev, the old scientist who used to roam over the steppe and ponder over how it could be changed.

A STORY OF TREES AND BUSHES

There's no such thing as a forest without trees. But it must also have bushes to be healthy. Why do the trees need honeysuckle, sweetbrier, currant, and acacia bushes?

We'll tell you a true story of something that happened in Germany many, many years ago, and then you'll understand why a forest needs its bushes.

The forester of a huge forest once decided to tidy it up. When a housewife tidies up her house, she takes a broom and sweeps out all the dust, crumbs, and scraps of paper. Then she polishes the furniture and puts everything in order. She keeps working away until the house is swept, dusted, and tidy. When the chief forester decided to tidy up the forest, he felt the thing to do was to sweep out all the trash and take all the useless things out. And what did he consider useless? Well, he knew that a forest means trees, and, therefore, everything that wasn't a tree was useless. The grass and bushes could be of no use, thought he, for their roots absorbed the water from the ground, taking it away from the trees. The fallen leaves and branches were useless, he decided, because they merely cluttered up the ground.

Dozens of labourers were ordered to clear up and sweep out the forest. They began by making a big pile of all the old leaves and dry

branches and burning them. Then they started cutting down the bushes and burning them too.

The forest became as clean and as airy as a house after spring cleaning. New trees were planted in straight rows in places left empty by old stumps. The trees in the forest were lined up like chairs along a wall, and there wasn't a speck of dust anywhere on the ground. The chief forester was very pleased at the orderly sight that greeted his eyes in every corner of the forest.

Three years went by, and he began to notice strange things in his clean forest. The crowns of the pines had thinned out and the leaves of the oaks and lindens had become transparent and sparse; the forest had become peppered with dead trees, standing there quite leafless and dried up; huge tree trunks lay across the paths, the victims of passing storms; autumn

was still far off, but the ground was covered with yellow leaves. Only a short time had gone by since the forest had been tidied up, but it was untidy once again, this time even worse than before.

The chief forester was puzzled. He couldn't understand why the trees had dried up. It was certainly not from lack of care.

This is what had happened. When the woodsmen swept out the forest, they swept out just everything—all that should have been swept out, and all that should have been left. The dry branches and dead trees were certainly of no use, but the bushes had been chopped down needlessly. The people thought that the only thing of importance in a forest were the trees and that the bushes were of no value at all. However, they found out from their own sad experience that the trees couldn't live without the bushes, for they began to dry up soon after the bushes had disappeared.

Were the bushes important?

Yes, they were.

A forest isn't just a forest, it's a densely-populated city. The houses in the city were the nests and burrows, and the inhabitants were the birds and animals. Some birds build their nests in trees, but many build their nests in the undergrowth. It's not easy to spot them there, for they dart into the thicket the moment they sense a stranger near by. Each bird has its own song by which it can be identified, and their songs are heard throughout the forest.

When the people chopped out the undergrowth, the birds that nested and hid there flew away and settled in other forests. It became quiet and lonely in the woods without them. However, that was only the beginning.

Something else happened that was much more alarming: the trees began to dry up when the birds disappeared.

Were the birds so important?

Yes, they were.

Birds never sit about idly on the branches. They scour the tree trunks, the branches, and the leaves from dawn to dusk, tidying up the forest in their own way. As soon as they spot a beetle or a caterpillar they snatch it up in their beaks and take it to their baby nestlings. Little nestlings are real gluttons. They grow very fast and eat an awful lot of bugs. Forest birds destroy thousands of bugs and caterpillars each day, but when all these birds had flown away, the beetles and caterpillars had the time of their lives. They multiplied and multiplied.

The trees began to dry up because they were swarming with insects. Some insects feasted on the leaves, others on the roots. The tree was their banquet table, and if such unwanted guests are not chased away from the table before it is too late, they will eat everything up, including the table itself. There were so many of them in the forest after the birds had left that they attacked the trees in regiments. The caterpillars were the first to advance. They chewed up the leaves and roots. What tree can live without its leaves and roots? It absorbs light and air through its leaves and water through its roots. The trees began to dry up without sunshine and air, and became weak from thirst and hunger. A weak tree has many more enemies than a strong one, and as soon as the trees began to weaken, new enemies appeared. They were the bark-beetles. They chewed through the bark and started boring long, winding tunnels under it, chewing up the wood as they worked, and carting out the sawdust on their backs.

If the tree had been stronger and healthier, it would have done away with the bark-beetles in no time by drowning them in the heavy, sticky sap that flowed under the bark. But the tree was no longer its old self, as it had been before the caterpillars overran it. It had dried out from

lack of food and water, and there wasn't much sap left in it. There was no one to defend the tree either, as the birds had all flown away.

The bark-beetles stayed on the job, boring away at the tree, till before long their tunnels merged, forming a bored-out band under the bark. The beetles had cut the road between the roots and the leaves and the live, healing sap could no longer flow beneath the bark.

The trees lost their last leaves. They still stood up straight in the forest, but they were dead.

However, their enemies would not even let them rest in peace. New beetles arrived. They were called stag-beetles and their feelers were longer than their bodies. They would bore straight to the centre of a tree and pierce it right through with their tunnels.

That's how caterpillars and beetles ruin a tree. In the course of a few short years they had ruined nearly half the trees in the forest.

All this happened because people chopped down the bushes in the forest.

Why had they done that?

Because they couldn't see the forest for the trees.

The chief forester thought that the forest began and ended with the trees. He was mistaken, for a forest is made up of trees and undergrowth, and birds, and beetles, and caterpillars.

All the plants and animals in the forest seem to be playing a game, and he should have found out the rules of the game before he began his spring cleaning.

Then the people tried to get rid of the insects themselves. They smeared the tree trunks with paste, hoping the caterpillars would stick to it, and they sprayed the leaves with a poisonous spray.

It was no use. There were too many insects by then and nothing could stop them any more.

The chief forester realized his mistake. If the bushes had not been chopped down, the birds would not have flown away.

We don't make such mistakes nowadays. We work according to the laws of science, and we know that everything in nature is linked to everything else. When we decide to change nature, we must never forget about this relationship. A woodpecker is not just a plain bird. He is a woodsman as well. He runs up and down a tree, tapping as he goes.

"Any bugs here? I'll eat them all!"

A forest even needs ants, for they too eat harmful insects and help keep the forest in order.

If you want to help protect a forest, you should remember to protect the trees and bushes and birds in the forest. Don't let anyone break off the branches on the bushes or destroy birds' nests or ant-hills.

WAR IN THE FOREST

When you walk in a forest it seems as if each tree is independent of all the others. Actually, though, the trees can quarrel among themselves or live together in peace.

Once, in the spring, people came to a fir forest and chopped down many tall trees, leaving the saplings all alone. The little trees had resisted the early morning frosts as long as their mothers had been with them, for the widespread, bushy branches of the big firs spread a green canopy over the ground and prevented the earth from getting cold. The little trees were in for trouble after they were left alone in the world. The morning frosts killed their buds and young green shoots; grass began to grow wildly in all directions in the sun-drenched clearing, although it had never stood a chance in the shady forest before. Then new tenants arrived. They were winged birch and aspen seeds that had flown into

the clearing. They took root and shot up rapidly and weren't afraid of the morning frosts, for the ground was now covered with grass. This thin, green blanket gave them quite enough protection.

The birch and aspen seedlings grew taller and taller, until, at last, their branches met, forming a solid green arch. It was as dark as a cellar all day long under the new roof. The little fir-trees had been left far below, but they didn't mind the darkness a bit. The grass did, though, and it started to wither away without the light. Its decaying blades mingled with the falling leaves and together they formed a crumbly, warm blanket over the ground.

The little firs began shooting up in the warm twilight, but the birches and aspens grew slower and slower with each passing year. The firs grew so fast that they became taller than their neighbours.

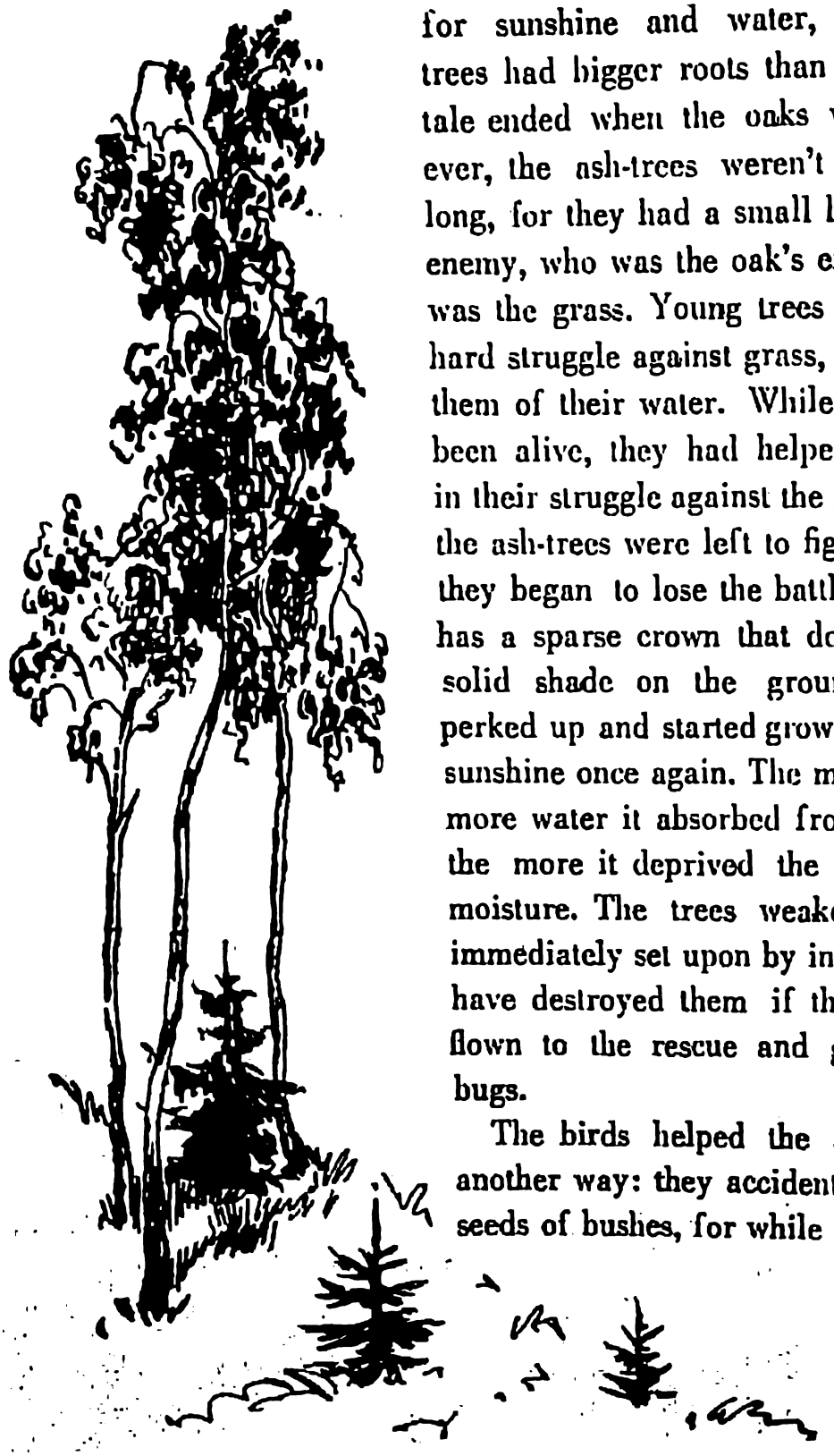
The birch-trees tried to put up a fight, and whenever it was windy they slapped the firs with their branches until the firs' green needles began to get yellow in spots and fall off. This wasn't enough to stop the firs, however, and their branches closed over the birches and aspens, dooming them, for they couldn't live without the bright sunshine.

And so, the fir-tree became the mistress of the forest again.

There was another case of war in the forest. Once, oaks and ash-trees had been planted in alternate rows. These two varieties of trees aren't at all alike. A young oak grows very slowly, while a young ash-tree grows quickly. Although all the trees had been planted at the same time, the ash-trees soon outgrew the oaks and blocked out the sunlight with their branches.

An oak-tree likes the sun to shine right on its crown, and the oaks were forced to lean every which way to catch a little sunshine. They became bent and crooked, but were still unable to poke their heads through the ash branches and reach the light.

So the oaks became sickly and covered with moss, and although they were still quite young, they already looked ancient. They were starved



for sunshine and water, for the ash-trees had bigger roots than they. The sad tale ended when the oaks withered. However, the ash-trees weren't victorious for long, for they had a small but treacherous enemy, who was the oak's enemy too. This was the grass. Young trees always have a hard struggle against grass, because it robs them of their water. While the oaks had been alive, they had helped the ash-trees in their struggle against the grass, but when the ash-trees were left to fight it out alone, they began to lose the battle. An ash-tree has a sparse crown that does not throw a solid shade on the ground. The grass perked up and started growing nicely in the sunshine once again. The more it grew, the more water it absorbed from the soil, and the more it deprived the ash-tree of that moisture. The trees weakened and were immediately set upon by insects who would have destroyed them if the birds had not flown to the rescue and gobbled up the bugs.

The birds helped the ash-trees in still another way: they accidentally planted the seeds of bushes, for while they were eating

the seeds, they spilt some on the ground and these seeds took root. The young bushes smothered the grass with the shade they cast on it. Even though the ash-trees' new allies weren't very big, they were very powerful, and so the trees and bushes lived happily ever after.

When the people saw what had happened, they realized that it was silly to wait around for the birds to sow the seeds for them and decided to take such an important matter into their own hands. They also realized that there was no sense in planting oaks and ash-trees close together if they were such enemies. Instead, they had to be planted as far away from each other as possible.

Thus, people came to understand the friendships and quarrels of the forest. Nowadays, in the Soviet Union, when forest belts are planted in the steppes, the people make sure beforehand that the trees there will have as many friends and as few enemies as possible.

Take the starlings, for instance. You can't even imagine how many caterpillars they eat every summer. However, a starling won't ever settle in a forest belt if he doesn't have a nice house ready for him there.

One has just alighted on the perch of his summer residence. He pokes his head through the little round hole and looks inside to see if it is already occupied. The cottage is still empty, so he hops inside. In a second, he has popped out again and is perched on a nearby branch. Apparently, he likes this nesting-box. There's a roof over the entrance, which means that the rain won't get inside, and the entrance itself is high above the floor, so that no cat could put her paw into the bottom where the babies nest, if she was hunting for a baby starling for her lunch.

The location is perfect, as there is a pond close by where the starlings can go for water. There will be many neighbours too, for all the trees in the vicinity have nesting-boxes. It is a real starling town. If a magpie comes and tries to steal a baby starling, all the neighbours will come to the rescue and chase the intruder away.

The cottage has been rented, and the starling begins to tidy it up and throw out all the bits of leaves and other rubbish he finds inside. When he's tidied up, he flies to the top of his birch-tree, flaps his wings, crooks his neck, and begins to sing the sweetest songs he knows, as if he were telling his wife, "Everything's in order, my dear. You can come home now."

After some weeks the mother starling will hatch out her young brood, and the father won't have time to sing any more. The parents have a great responsibility now. They have to bring up their babies. Sometimes, starlings even drop from exhaustion, after flying back and forth, to and from the nest, carrying food for their young. And no wonder—the little birds grow very fast and need a lot of food. The starlings never realize that when they feed their young they also help people by protecting the gardens, orchards and forests from insects; they pay for their cottages with their hard work.

Many other inhabitants of the forest are engaged in similar work. The tit, the golden-crested wren, and the finch belong to this group, and when a forest belt is planted, different ways are found to coax these birds to make their nests there.

This is a more difficult problem that it might seem to be, for birds always nest in the place of their birth, just where their parents and their grand-parents nested. They travel thousands of miles each spring over land and sea to reach their nesting grounds. What can be done to persuade these birds to return to the forest belt in spring, instead of to their native nesting grounds?

You never have to wait long for the sparrows to arrive, but finches won't change their nesting ground of their own free will. They have to be tricked into it. This is how it is done. Finch eggs are put into sparrows' nests. The little finches hatch and grow up over the summer and their trusting foster-parents never realize that their children don't look a bit like themselves!

In the autumn the young finches fly southward for the winter, and the next spring they all return to the place of their birth—the forest belt!

Let's have a look at the tit. It makes its nest in a hollow tree. All the trees in the forest are young and healthy—there are no hollow trees there.

It would certainly be foolish to hollow out good trees in order to provide the birds with houses. But there's an easy solution to this problem, for a bird's house can be made to look like a hollow tree by hollowing out a little log and hanging it on a tree trunk.

This is how people take part in the war that's going on in the forest. They help the trees to fight off the insects, the caterpillars, and the grass.

THE STORY OF THE BRAVE STEPPE BUSH

There's a desert in the Soviet Union called Kara-Kum. Huge sand mountains move across it, burying everything in their wake. If a house or a tree stands in the path of the moving sands, it'll be buried forever beneath them.

People are forced to leave their homes and orchards to the mercy of the wind and the sand.

The first to perish are the peach and apricot trees. They dry up before the sand has even reached the middle of the tree trunk. The desert elm is the hardiest of all, but even then, there's nothing but a dry stump left of it after the sands have passed on further.

The people keep moving back, building their houses further away from the sands, but it's no use. They build tall clay walls around their houses to hold back the sand, but it keeps on creeping forward. The wind piles it higher and higher, until the sand has reached the top of the walls and is ready to invade the forts. The besieged defenders build new walls on top of the old ones. The walls grow higher and higher, but the mountains of sand grow too, and push hard against the clay walls. A grain of sand is very light, but a sand mountain weighs many tons. Finally, the walls give way before the sand which invades the houses. There's no stopping the sand any more.

The wind and the sand used to be the sole rulers of the desert. Neither people nor grass and bushes ever had a chance in the Kara-Kum Desert. It was hard for the plants to take root when the sand kept moving out from under them, because it's very easy for a strong desert wind to blow it out from under the roots of a bush, whirl the bush up, and lay it out dead on the sand. Sometimes, the wind carries a few seeds into the desert to play with. It throws them on the sand and says, "Go ahead, grow!" And in the next second it has covered them over with sand. A little green shoot might poke its head up, if it's lucky, but it has no chance of growing big, for a wave of sand will sweep over it and bury it forever.

There's a bush in the Kara-Kum Desert which knows how to fight the wind and sand, and which is called a steppe bush. It never creeps into the desert, but comes hopping bravely along, straight into the sands. Its seeds are hidden in a round nut; when the wind blows, the nut bounces like a ball. The sand can't catch up with it and smother it, because it's heavier than the nut. And so, the steppe bush beats the sand from the very start.

It's not hard to land in the desert, but it's quite difficult to survive there. If the little seed in the nut grows into a bush, how can it ever escape the sand mountains? A bush can't bounce or hop along, you know, it would be buried alive under the sand, like the peach and apricot trees in the orchards.

The steppe bush doesn't give up so easily, though. Its branches aren't at all like the branches of fruit-trees, for they have no leaves on them. When the sand blows up around the steppe bush, the bush doesn't put up a fight. Instead, it lets the sand slip through its branches, and the sand is compelled to slip through without harming the bush in the least. The wind is very displeased at such a turn of events and starts blowing harder and harder, sweeping the sand out from under the bush.

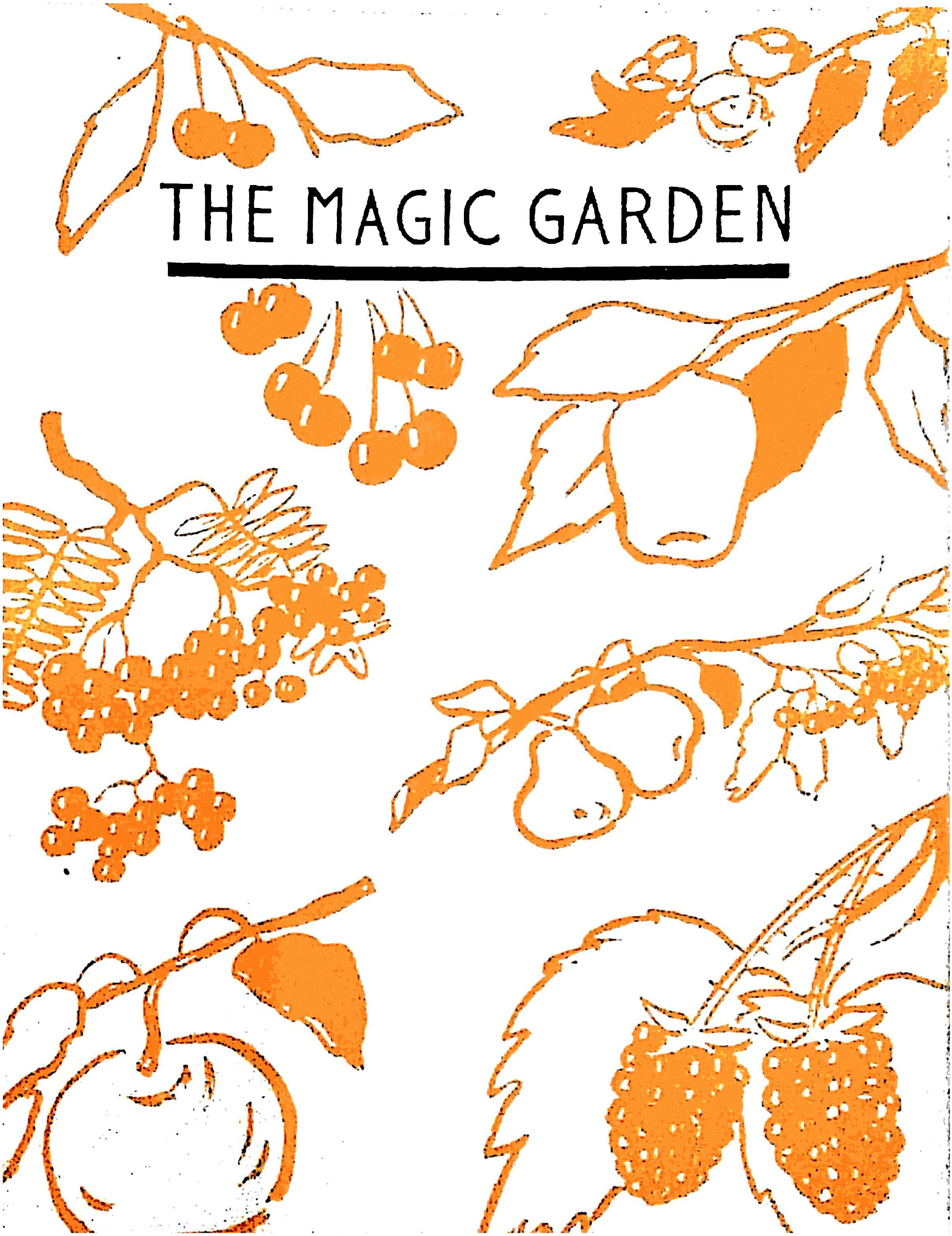
The wind is helpless if the steppe bush had a chance to sink its roots deep into the sand. But if it is still young and not firmly rooted its fate is sad, indeed. The wind will tear it up, roots and all, and leave it lying on the sand to die. Even then the steppe bush never gives up, for as soon as it finds itself lying on the sand it sprouts new roots and hangs on to the shifting sand for dear life, stopping it in its flight, gathering it under its roots, and creating its own sandy base.

The wind gets furious and blows a whole mountain of sand over the bush, but it still keeps on growing under the heap. The wind keeps adding more and more sand to the top of the pile, and the bush keeps growing and growing too. Soon, it reaches the top of the sand hill and looks out at the world around it. Then the wind starts blowing again and tries to move the sand hill further on. But the hill can't budge, for the bush is holding on to it with all its roots and branches. And when the hill finally does move on, it leaves a good half of itself behind, around the steppe bush.

That's how a steppe bush fights the wind and sand.

When the people found out about this, they started planting the seeds of this bush and others like it in the desert. The bushes march ahead, tying down the sand; then come the people who build houses and plant orchards in the conquered desert.

THE MAGIC GARDEN



THE MAGICIAN

There's a city called Michurinsk in the Soviet Union, and there's an orchard as big as a forest in that city.

In the spring, when the trees are in bloom, it looks as if an enormous pink-white cloud has come to nestle on the earth. In autumn there are so many bright fruits on the trees that you often can't even see the green leaves at all.

There are many large orchards in the world, but nowhere is there another like the one in Michurinsk, for it's a magic orchard. Fantastic

fruit, flowers, and berries that have never been seen before grow there. There are pears that are sweeter than honey. If you drink tea and bite into one of those pears, you won't need any sugar for your tea. There are lilies that smell like violets, roses that smell like carnations, and jasmine that smells like wild strawberries.

There are fairy-tale trees there too: one is half sweet cherry and half bird cherry; another is half plum and half apricot. There's a mountain ash there too, not just an ordinary mountain ash, but a very special kind.

You've probably seen mountain ashes before. In the cold, dreary days of autumn their fiery berries brighten up the gloom. Little girls make lovely beads from them, boys use them for ammunition in their pea-shooters. But you'd never eat them, because they're so tart and bitter that they pucker up your mouth in a second.

What a miracle it would be if these berries suddenly turned sweet! The miracle happened in the magic garden, where the branches of the mountain ashes are covered with clusters of sweet, dark-red fruit. You don't have to climb high to pick it, because the trees are very small, and they seem to be inviting you to eat to your heart's content.

The same miraculous change came over the blackthorn-tree with its tart sloes. Its thorns are so sharp that you'd think they were protecting a great treasure from thieves. Actually, though, it has no treasure, for its fruit is small and tart and bitter.

The blackthorns in the magic garden are magic too, because they have large, sweet, dark blue plums. The trees there have been given a much nicer name, and are called sweet blackthorns.

There are trees with large, yellow-green fruit in the magic garden. One day, two boys saw this fruit and the first one said, "Look at the apples!"

The other didn't agree. "They aren't apples, they're pears! An apple has a stem that's set in a little hole, but these have bumps instead of holes, just like pears."

They tried to end the argument by tasting the fruit. Each one took a bite.

"I'm right," said the first boy. "It tastes just like an apple."

"Oh no," said the other boy. "It tastes just like a pear."

The boys asked a gardener what the fruit was called, and he said it was a Reinette Bergamotte.

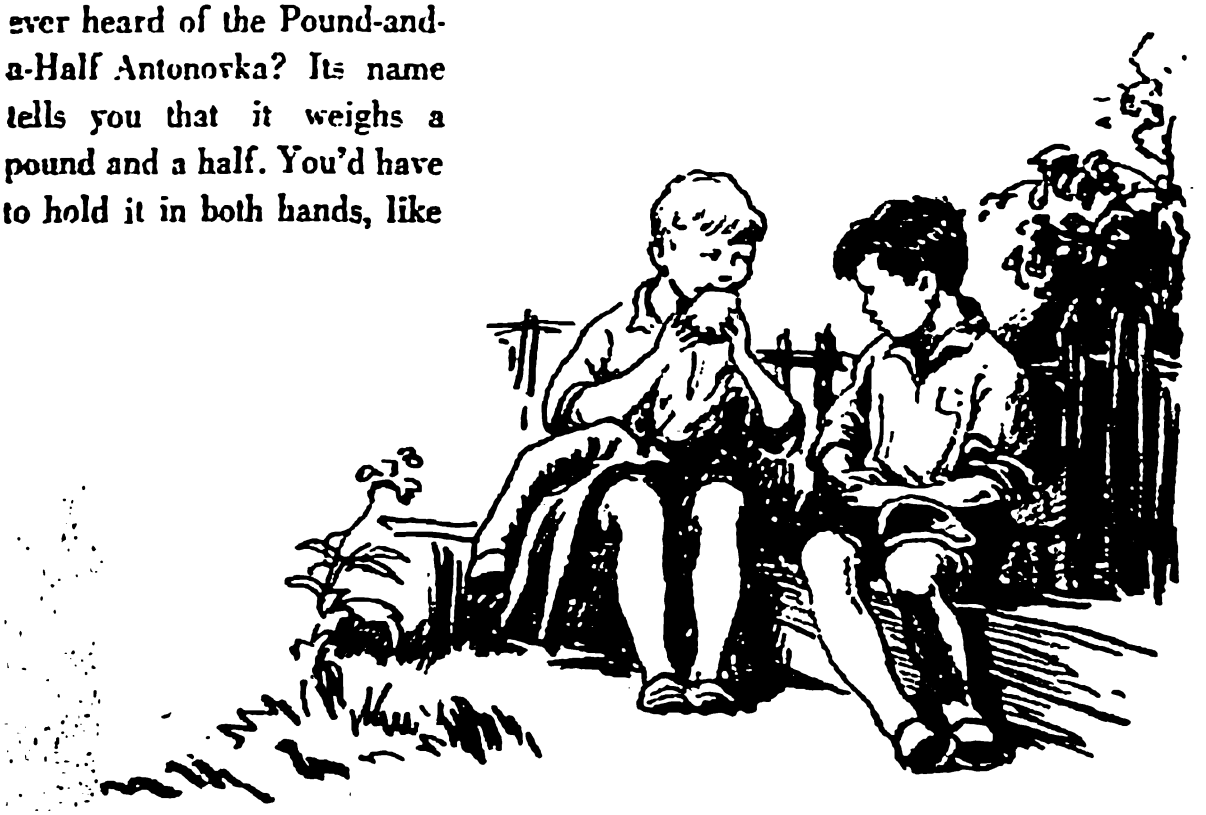
"I was right after all," said the first boy, "because I know that a Reinette is a kind of apple."

"No you weren't," said his friend. "Don't you know that a Bergamotte is a pear?"

The boys went off to find the gardener again, and asked him what a Reinette Bergamotte was: an apple or a pear?

The gardener said, "It's a kind of apple that's grown on a pear-tree."

There are other wonderful fruit-trees in the magic garden. Have you ever heard of the Pound-and-a-Half Antonovka? Its name tells you that it weighs a pound and a half. You'd have to hold it in both hands, like



a melon, not to drop it. An ordinary apple looks like a midget next to it.

The garden is full of southern fruits. There are apricots, big juicy pears, and grapes. But the orchard isn't in the south, it's in the north! The winters there are cold, there's a lot of snow, and the ground is covered with frost in the mornings far into the spring.

Southern fruit-trees are usually afraid of the slightest chill, they're delicate and pampered by a warm climate. But here the grapes, and apricots, and pears, and cherries resist the frost and blizzards, and aren't in the least afraid of the cold. Their names reflect their hardy natures: Northern Apricot, Siberian Grape, Winter Pear, Pride of the North Cherry, Taiga Apple.

There's a cherry-tree in the orchard that has become world-famous. It has been called "Plodorodnaya" ("Fruitful") because it bears so many cherries. Its branches are heavy with shiny, dark red fruit. A single little cherry-tree of this sort can bear as many as eighty pounds of cherries, and it's hard to understand why it doesn't collapse under such a load. The tree is even more famous for its ability to survive in cold weather.

Many years ago Canadian horticulturists heard about this wonderful tree and imported it into Canada, as the winters there are very cold. One winter, in particular, was so cold that all the other trees in the orchards perished.

In the spring the Canadian horticulturists got together to talk about their orchards, and it was then that they found out that of all the varieties of cherries, the Russian "Plodorodnaya" was the only one that had survived the winter. Since then, the Russian visitor from beyond the seas has become very famous and popular in America.

Who created the "Plodorodnaya" cherry-tree? Who moved the south northwards and created the Northern Apricot, Siberian Grape, and the Pride of the North Cherry? Who was able to make the bitter mountain

ash sweet and the tart sloe so tasty? Who conjured up the magic plants called cherry-bird cherry, plum-apricot and apple-pear?

Let's see what's printed on the labels in the orchard:

Michurin's Plodorodnaya Cherry

Michurin's Winter Pear

Michurin's Dessert Mountain Ash

Michurin's Best Apricot

The magician who created the magic garden was Ivan Michurin, and it was in his honour that his native city of Kozlov was renamed Michurinsk. He devoted his whole long life to the study of nature, and to finding ways of changing it. He saw a plant as a sculptor sees a lump of clay, and he moulded new and wonderful fruit from this living clay. He said, "Man can and should create new types of plants much better than nature does."

From early childhood Michurin spent every free moment he had in gardens and orchards. Usually, when a boy gets hold of a penknife, he starts whittling, or makes himself a catapult, or a bow and arrow. But when Michurin was a boy he used his penknife to practise grafting the buds and scions of trees on to other ones.

When a doctor operates on a patient, he must have a lot of knowledge and skill. It takes a lot of learning to become a doctor; it takes a lot of learning to become a tree-doctor too.

Michurin spoiled many a branch in his childhood before he learned how to cut a bud from a branch quickly and skilfully, how to make a slit in the bark of another tree, fit the bud in under the bark, and then bandage the wound with a piece of bast. He would anxiously await the outcome of the operation, and it was a happy occasion, indeed, when a grafted bud would grow into a green shoot.

If he happened to be eating a particularly tasty apple or pear, he'd never throw the seeds out or split them and then eat the kernels; instead, he'd put them away, in order to plant them later in his own small orchard.

From the time he was a little boy Michurin felt disappointed that the northern apples and pears were never as tasty or as juicy as those that grew in the south. He dreamt about having grapes and apricots and peaches in his own orchard in Kozlov some day. When he grew older he spent many evenings pouring over a map. He would draw a line across it, marking off the northernmost area in which the apricot or peach tree continued to bear fruit. His city was many hundreds of miles to the north of the discouraging line, and he tried to think of ways to move it up and make the northern orchards as beautiful as the southern ones.

Not every dream comes true, but his did, and even in his lifetime, because, aside from dreaming, he also knew how to work patiently and persistently, year after year, decade after decade.

THE STORY OF FIVE SISTERS

Michurin once knew a gardener who had a Beurré Royal pear-tree growing in a large flower-pot. It was a wonderful pear-tree, and its fruit was so juicy and so tasty that it would just melt in your mouth. But it grew in a hothouse. It would have perished from cold the very first winter it was left out in the open. Michurin decided to create a pear just like it for the north, one that could be planted in orchards instead of hothouses.

To do this, he decided to cross a southern Beurré Royal pear with a hardy northern pear. He knew that children usually resemble their

parents and, therefore, he thought the Beurré Royal's and the northern pear's children might also resemble their parents. He hoped there might be some among them that would be hardy, like their northern mother, and would take after their father in every other way.

And so, he started looking for the right mother for these future children and remembered the wild Ussuri pear-tree in his own orchard. Its fruit was small and tart, but it didn't mind the fiercest frost. It had come from a region near the far-off Ussuri River, where the winters are cold and harsh, and the trees that had been growing in the dense Ussuri forests for thousands of years had become accustomed to the cold.

Michurin waited until both the young Ussuri pear in his orchard and the Beurré Royal in the hothouse blossomed in the spring. Then he touched the blossoms of the Beurré Royal with the tip of his finger and carried the pollen which clung to it over to the blossoms of the Ussuri pear. The fruit that began to grow after the blossoms had fallen was very unattractive, but Michurin wasn't concerned with the pears, all he wanted were the seeds inside them. When the pears had ripened, he picked them, cut them in half, took out the seeds and planted them, anxiously awaiting the results.

Five pear-trees grew from five of the seeds.

They were all sisters, but there wasn't much of a family resemblance among them:

One bore pears with red spots.

One bore pears with grey spots.

One bore pears with green spots.

And two were failures, for their fruit was small and tart.

Colour was not the most important factor, but taste and the size of the pears were.

Michurin named the pear with the green spots Beurré Tolstobezhka because it had thick shoots. It resembled its mother, the Ussuri pear, in its hardiness, but its pears were large and sweet.

He named the pear with the bright red spots Rakovka; its fruit was just as large and tasty as the Tolstobezhka.

The sister with grey spots became most famous. It was named Michurin's Winter Pear. In spring, when it was in bloom, its branches were lost among the large white blossoms. It bore so many pears that the lower branches dipped down to the ground under the great weight of the fruit. Each tree bore hundreds of pears. And what pears they were! They were juicy, and sweet, and enormous!

Michurin was really happy to see that the little tree that bore such delicate and delicious fruit was by no means frail. The Winter Pear had inherited its hardiness and disdain for cold, snow, and blizzards from its wild mother. Even the fiercest frost could not wither a single

branch of the new tree. But fruit-trees have an enemy that's much worse than the winter frost—its younger brother the spring frost.

In the spring the days are much warmer and the trees begin to blossom, but in the early dawn, before the sun has had a chance to warm the earth, the frost is busy at work. It covers the puddles on the road with a film of ice and freezes the fruit blossom.

The Winter Pear turned out to be much hardier than many other fruit-trees. Although the morning frost froze its petals, it still bore its fruit. Sometimes the fruit-trees were blighted by pests that fed on the buds in the spring. The Winter Pear was determined to win the battle, and even after the pests had damaged the buds, the blossom still turned into a pear.

Many a time a strong wind would sweep through the orchard. The branches of the trees, heavy with ripe fruit, would start swaying, and the orchard would be full of the thudding sounds of falling fruit. The

Winter Pear did not let the wind rob it, and its fruit would hold on fast to the branches.

The pears retained their hardiness even after they had been picked. Usually, the more delicate the pear, the easier it spoils. If a pear is bruised in shipment, the bruises begin to rot, and when the fruit is unpacked, it will be bad. Not so with the Winter Pear. If it is bruised, it starts healing its own wounds and they disappear by themselves! That's why it can be shipped anywhere. Usually, pears cannot be kept all winter but must be eaten soon after they're picked. The Winter Pear was so named because it keeps until March or even April.

The new crop is still a few months off, but the Winter Pear has become still more delicious over the winter and has turned golden. It seems to be saying, "Please eat me!"

Such is the wonderful pear Michurin created by crossing a southern pear-tree with a northern one. However, he knew that finding the right parents for a new variety of pear or apple and selecting the best of their children was only half the job. The children had to be brought up correctly, and that was the hardest job of all. How did he educate his young charges? You'll find this out if you read the next story.

THE STORY OF TWO APPLE-TREES

Once upon a time, there were two apple-trees. One grew in the south, the other in the north. The northern tree was called a Kitaika. Its tiny apples were red, but slightly bitter. The Kitaika had something to be proud of, because it was as hardy as the Ussuri pear, and no frost or blizzard could ever harm it.

The southern apple-tree lived in a mountain valley in the Crimea and was called a Candile-Sinap. The mountains protected it from the wind, and the hot southern sun tinted each apple golden, giving it a pink flush on one cheek. The summers were long there and the apples ripened slowly, growing big and juicy. The beautiful trees had one fault: they hated the snow and cold, and couldn't live outside the warm climate of their native south.

One autumn, when the bright long-shaped apples were ripe, people came with ladders and baskets and picked them all off the trees. They packed them in crates, taking care to protect the apples from rubbing against each other on their journey, and they drove them to the railway station. Thus, the Candile-Sinaps found themselves in a goods waggon with many other varieties of apples.

The waggon became so fragrant, the people everywhere would stop and say, "Doesn't it smell good? It must be a shipment of apples." One crate of Candile-Sinaps was shipped to the city of Tambov, and from there to the city of Kozlov, where it ended up in a fruit shop. Passers-by would stand and admire the luscious fruit in the shop-window, but few, indeed, could buy the expensive beauties. One of these apples finally found its way to Michurin's table.

If you happen to be eating a very tasty apple you enjoy it while it lasts and then forget about it. But Michurin admired the southern guest for quite a while and even sketched it in his diary.

"What a beauty!" he exclaimed. "No other apple can compare with its colour, its shape or its taste. If only it would grow in our northern regions..."

He thought back to his previous experience in cultivating southern fruit in his orchard. When he was still a young man, he used to take branches of delicate southern apple-trees and graft them on to hardy northern varieties. But no southern apple ever ripened in his northern orchard. The southerners would perish from the cold during their very first winter up north. Michurin was persistent and would not accept defeat; he never gave up his idea of some day growing Crimean apples in the north. He thought, "A mature tree that has been pampered all its life by a warm climate will never get used to the cold. But what if it gets accustomed to the snow and blizzards while it is still a baby, from the very first year of its life?"

In order to do such a thing, it would be necessary to take a seedling, a little shoot that had grown from a seed, instead of a branch from a mature tree. That's exactly what he did. He took some Candile-Sinap seeds and planted half of them out in the open in his orchard and the other half in flower-pots in his study. Little green shoots burst forth from the seeds, and he was pleased at their rapid growth. His joy was short-lived, however, for the first icy blast of winter killed the little seedlings out in the orchard. The ones in the flower-pots survived, for they had grown up in the warmth of his study. So you see, the Candile-Sinap's children had turned out to be just as delicate as their parents.

Michurin wondered whether anything could be done, and he reminded himself of his hardy northern Kitaika. In the spring, when all the apple-trees were in bloom, Michurin decided to cross the modest Kitaika with the Crimean visitor. He took some pollen from the blossoms of the Candile-Sinap and put it on the blossoms of the Kitaika. As could be expected, the Kitaika produced the same kind of apples as it always had, but new trees that were the children of the Candile-Sinap and the Kitaika grew from the seeds of these apples.

Michurin anxiously awaited the coming of winter and the results of his experiments. If the young trees resembled their mother, they would

survive the cold, but if they took after their southern father, they would freeze to death.

The new trees survived their first winter, but as the second, and then the third winters came and passed, Michurin realized that the young trees were beginning to suffer from the cold and change in appearance, until they had become more like their father than ever before. Then he decided to let their own mother take care of them and harden them. He cut some buds from the best of the young trees and grafted them on to the branches of their maternal Kitaika tree, so that she could nourish her own children herself.

Soon young green branches sprouted from the grafted buds. Winter followed winter, but the little sprouts withstood the cold and kept getting stronger and branching out.

When first the blossoms and later the fruit appeared on the branches Michurin was sorely disappointed, for nothing good had come of his second experiment. The apples were small, unattractive, and tart.

Someone else might have become angry and replaced the useless tree with another. But Michurin was a great scientist and he

knew that you should never judge a tree by its first fruit. He took care of his charge patiently and lovingly, and often thought of the story of the ugly duckling who grew up to be a beautiful swan.

His green charge rewarded him for all his troubles. With every passing year the fruit it bore was tastier and better looking. In taste and colour and shape the new fruit resembled the Crimean Candile-Sinap, but it had also inherited its mother's hardiness.

Thus, Michurin had finally created a new variety of apples: Candile-Kitaika. He had been persistent and devoted to his work, he had never lost faith in his undertaking, and he had not given up when he was faced with failure. It took fourteen years to grow and cultivate the Candile-Kitaika. So many children had started school and graduated during those fourteen years, but the Kitaika apple was forever being left back in Michurin's school.

It had only had one nurse, and that was its own mother, but its close relative, the Bellefleur-Kitaika, had eight nursemaids. The first nurse was its mother the Bellefleur apple-tree, and the last was the Pound-and-a-Half Antonovka. Each of its eight nursemaids had given it some of its own features through the sap that flowed into the young shoots. One taught it to resist the cold, another helped it to grow larger fruit and a third made it less susceptible to spoilage, so that the apples would preserve their freshness all through a long winter in a warehouse. However, we should thank the one who guided the work and not the nurses, for it was he who had grafted the branches of the nursemaids on to the young tree.

Michurin used other methods of cultivating young trees. When he had to accustom a delicate sapling to the harsh climate and life in the north, he would try to harden it by planting it in inferior soil, so as not to pamper it. He even transferred his whole orchard to a spot where the soil was much inferior. His neighbours thought he was mad, but he knew what he was doing. He wanted the delicate and pampered saplings to get used to all kinds of ups and downs.

Sometimes, just the opposite happened, and he'd start to increase a young tree's food by planting it in very good soil and even fattening it up with sugar, injecting a sugar syrup under the bark of the tree. In this way he cultivated a pear-tree whose pears were sweeter than honey.

We haven't finished the story of the Candile-Sinap though. Michurin was able to move the Crimean apple-tree to Kozlov, nearly a thousand miles to the north of its native valley. He was still dissatisfied and began to think of a way of growing it further north. There are cold regions in the Soviet Union where the only apple-trees that can survive are the wild ones in the forests. People live in these cold regions and the many children there would love to eat apples too. His problem was to find a way to make a sweet apple-tree grow in the far north and in the dense Siberian taiga.

Michurin remembered that there was a kind of crab-apple that grew in Siberia, whose fruit was as small as berries. Michurin dusted it with pollen from the blossoms of the Candile-Kitaika, and when the fruit appeared, he gathered the ripe apple seeds and planted them. The Crimean Candile-Sinap was the grandfather of the tree that grew up from one of these seeds, and the Candile-Kitaika was its mother. Michurin named it the Taiga Apple, for he created it for the taiga. The tree was as small as a little bush, no higher than a man's knee. It blossomed close to the ground, but instead of being disappointed by the little tree's lack of height, Michurin was very pleased, for a little tree would have no trouble in finding shelter from the winter's frost beneath a thick snow-quilt. The experiment was a success, for the Taiga apple-tree bore small, but very sweet apples.

And so, a magician named Michurin moved the Crimean apple-tree to the city of Kozlov and then to Siberia. It had changed its appearance on the way; in its native Crimea it had been tall with graceful branches, but by the time it reached Siberia it had become a dwarf. The little tree had fulfilled its mission, and had brought sweet apples to Siberia.

HOW MICHURIN CREATED AN APPLE THAT WAS LIKE A PEAR

Apple-trees and pear-trees have grown in orchards for thousands of years. The apple-trees have always borne apples, and the pear-trees have always borne pears, as they were supposed to. And never, never had pears grown on an apple-tree, or apples on a pear-tree. But that's just what Michurin wanted to do; he wanted to create something that had never existed before and he believed that man could change nature to suit himself. That's why he decided to cross an apple with a pear. He had an Antonovka tree in his orchard, the sort whose huge apples each weigh a pound and a half. This was the apple-tree he used for his experiments. He could have just cut a branch or a bud from it and grafted it on to a pear-tree. But he realized that an old apple-tree would be set in its ways and that it would be very difficult to change its nature. It would be much easier to influence a youngster.

So he split a huge Antonovka apple, took out a round dark seed, and planted it. A tiny tree with dainty green leaves appeared in the orchard.

If the tree had been left there, it would have matured into a normal apple-tree. But since Michurin had decided to cross it with a pear, he cut a few buds from the seedling and grafted them on to a young pear-tree. First shoots and then branches grew from the buds, and the branches became covered with leaves. Little by little Michurin kept cutting off the pear branches until he had a strange and magic tree: it was an apple-tree on top and a pear-tree on the bottom. Just as a nurse holds a baby in her arms, the pear-tree held the apple-tree in its arms and fed it. And because it was fed by the pear-tree, the leaves and branches of the apple-tree began to look more and more like those of its nurse.

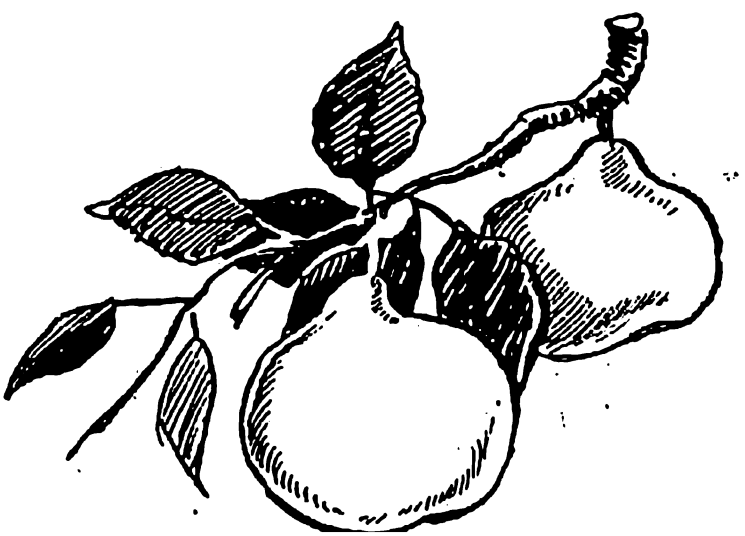
Suddenly, disaster struck. The pear-tree became seriously ill. What

was to be done? Should a new nurse be found for the child? Michurin had no intention of doing anything of the sort, for he feared that a new nursemaid would have her own ideas of child-rearing and would try to change the child accordingly. Therefore, he decided that the youngster was sufficiently grown up by then to be on its own. He bent the trunk of the sick pear-tree down to the ground, so that the place where the apple-tree had been grafted on to it touched the soil; then he covered the spot with earth. The apple-tree sprouted roots and lived by itself from that moment. The fact that it had been nurtured by a pear-tree had had a very definite effect on it.

When the first apples appeared on the tree they turned out to be of a very special kind. They resembled pears so much that everyone who saw them stopped to ask, "What are they, apples or pears?"

That's how a strange new tree appeared. Everyone waited to see whether the tree's descendants would resemble it, for then Michurin would have really created a new variety. After the trees grown from the seeds of the strange new tree had matured, they bore fruit that was a mixture of a pear and an apple, and so all doubts as to the new variety being a freak vanished.

Michurin created many amazing plants. But for him, there would be no Northern Apricots or Northern Grapes, no Sweet Mountain Ash or many other fruits. Or else, if they did appear some day, it would have been after many, many centuries of natural evolution. Michurin once said, "We must erase time and bring the beings of the future to life, for whose appearance we would otherwise have to wait centuries."



He was able to conquer time and bring the future to life. Not only did he cross delicate southern plants with hardy northern ones, he also experimented with unrelated species: he crossed a plum with an apricot-tree, a sweet cherry with a bird cherry, a blackthorn with a plum, a mountain ash with a hawthorn and a medlar.

His work was not easy, but nothing could make him give it up. Once, a river flooded his orchard and then a frost followed close on the heels of the flood, burying the young trees under a layer of ice. Many valuable plants perished. Although he had cultivated them with such patience and such care, he refused to be discouraged by the disaster and started working even more persistently. Every one of his experiments took many years before its results could be seen, as it takes many years to grow a tree and wait for it to bear fruit.

In his day, the gardeners believed that a good variety of apple or pear was just a stroke of luck, but Michurin knew that there was no sense in relying on luck alone. He used to say, "We can't wait for favours from Nature; we must wrest them from her."

There was a time when Michurin would look at a map and think of the possibility of some day growing fruit in the north. Nowadays, it's no longer just a young boy's dream, for he made it all come true.

He created three hundred new varieties of fruit and plants in his orchard and, what is more, he founded the science which teaches man how to create new plants.

He should be an example to us, for all his life he worked on new and useful projects and never gave up when the going became rough.

When he started his life's work, he had no orchard of his own, and he had to plant his apple and pear trees on a plot of wasteland near the city dump. He had so little land to work with that he had to plan out each inch of space. He worked long hours as a watchmaker in order to make enough money for his experiments, to buy new seeds, scions, and seedlings. When he once had to transfer his orchard to a new place,

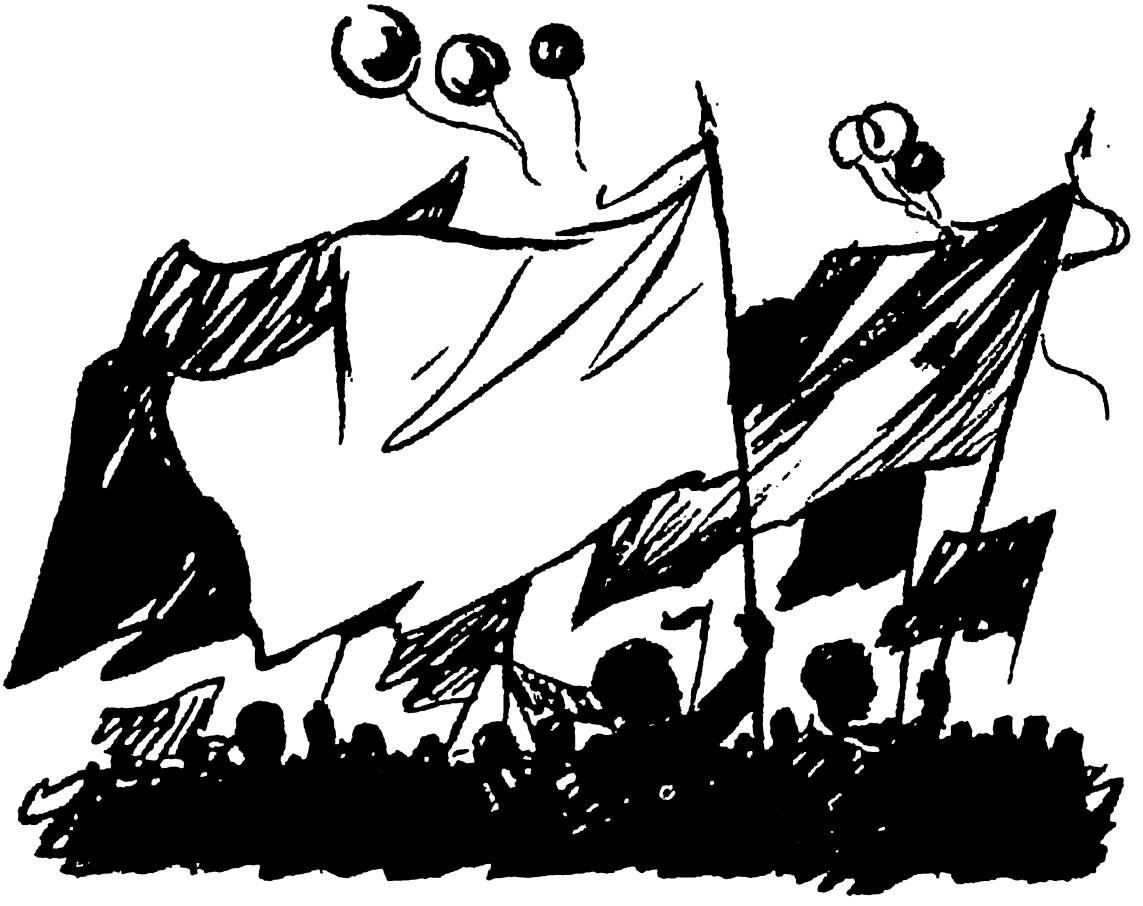
he had no money to hire a cart, and so had to carry his green family of young apple, pear, and cherry trees on his back the four miles to the new site. Few people understood then what amazing discoveries Michurin had made. He was a great scientist, but he was regarded as a simple, self-taught gardener, because he was not a professor.

The tsarist government did nothing to aid him, and the officials only hindered his work.

Everything changed after the Soviet government came to power—then the whole country aided the scientist.

There are many orchards in the Soviet Union where Michurin's wonderful fruit grow. Thousands upon thousands of his followers are carrying on his work and creating the plants of the future.

WE HAVE A CELEBRATION



WE HAVE A CELEBRATION

You can tell if there's a holiday in a home right away. The rooms are extra clean, the table has been extended to make room for the guests and is covered with a snow-white cloth. There's a wonderful aroma coming from the kitchen. Everyone is dressed up for the occasion. Your hands have been so clean all day long that you're even amazed at yourself. You feel a bit strange in your new clothes, but you're willing to make the sacrifice in honour of the special occasion.

Time seems to drag. You don't play at all, for you've been forbidden to move the chairs around or pull your toys out and scatter them all over the floor. The scissors and cut-outs have a day-off today too.

You've nothing to do till the company comes, except sit primly on the couch and read, or listen to the radio, or just look out of the window. This is the one time you're really glad when your mother sends you to the grocer's on an errand, or to a neighbour's to borrow something. But what merry-making begins when the guests have arrived!

That's how we celebrate a birthday or an anniversary at home. There are some anniversaries which are celebrated by all the tenants in the house, by everyone who lives in our street and in our city, and in every city of the Soviet Union.

Several days before May Day or the 7th of November, the birthday of the Soviet state, the city begins to take on a new look. Flags are hung from the windows; red banners with slogans on them are stretched across the buildings; portraits in evergreen frames are fixed to the walls; electricians spell out words in electric bulbs. Thousands of multi-coloured lights flicker on and off on the houses and over the roof-tops during the holiday; fiery wheels spin high up in the air; fiery snakes run down along the walls from the roofs to the ground, and shining slogans glitter everywhere.

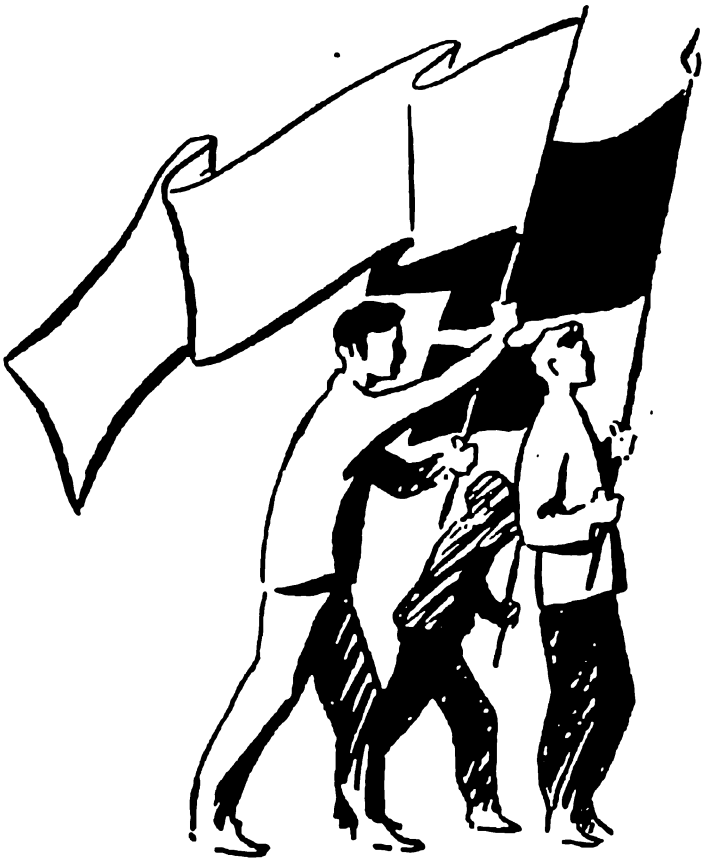
On May Day the letters will light up one after the other to spell out "May Day"; on he 7th of November,

numbers will light up and you'll be able to tell how old our state is from these numbers.

You turn the pages of the calendar impatiently, wondering if the big day will ever arrive.

On the eve of the holiday you keep looking up at the sky all day long, like a pilot before taking off on a long flight. What will the weather be like tomorrow? If it's a nice day, your father will take you to the demonstration.

Finally, "tomorrow" becomes "today."



You get up early and look out of the window. What luck! There's not a cloud in the sky. There's no traffic in the street today, everything is strangely quiet in the city. The sound of music can be heard somewhere in the distance and people are walking right down the middle of the streets. Stands are opening up here and there, vendors in white smocks are unpacking crates and baskets of sweets, apples, and biscuits.

You rush to wash up and dress. You're all ready in a flash, and out on the pavement.

Finally, the first column appears far down the street. There's a band in front and their brass instruments gleam in the sun. Some have great deep voices and others high, piping ones. The big bass drum is the loudest of all. Its voice is so low and important that it surely considers itself the outstanding member of the band.

There's a standard-bearer at the head of each column. Here come the workers of a shoe factory. The column following them is from a print-shop, where books are printed. They are followed by tram-drivers and conductors.

We've spent many evenings together, talking about the people who create everything that surrounds you. We spoke of loggers and miners, bricklayers and foundry workers, of bakers and plumbers, mechanics and stokers, of electricians, tannery workers and weavers.

They are the ones who are responsible for everything you have, from your pencil and note-book to the roof over your head.

There are schools and children's theatres in the Soviet Union, there are children's libraries and children's stadiums, and even children's railroads with locomotives—small ones, but they're real—and waggons and stations, station-masters in red caps and red pioneer ties.

No country in the world takes such good care of its children, and they must work well to deserve such attention. Everyone works in the Soviet Union and the children must all work too. A schoolchild's job is his school-work.

Today's holiday is the working man's holiday: look, here come the coat-makers from the very same factory where your coat was made. They are followed by the bakers; you eat the bread and buns they bake every day.

There are so many factories in the Soviet Union, so many mines, electric power stations and railways and there are ever so many workers in all these industries. Each one has his own job to do, yet they all work towards the same goal.

How do all these people from all over the country get together to work in harmony? It's easy for them to agree on something when they all live in the same village. All they have to do then is to call a meeting of the villagers and elect the best workers to the Village Soviet, which conducts all local affairs.

In order to make sure that there will be order in the city, the inhabitants elect their District Soviet and City Soviet. The citizens of the whole country, both city-dwellers and country-folk, send their elected delegates to the Supreme Soviet, the parliament which governs the whole country.

Who is elected? The workers that work best and most conscientiously in their factories or collective farms, and who are always concerned with the people's welfare. These delegates will be able to take care of the welfare of the whole nation.

When the Supreme Soviet is convened, the delegates all gather in Moscow. Some come by rail, others arrive by river-boat, and delegates

from very remote corners of the land arrive by plane. The deputies gather in the Kremlin in a large beautiful hall.

There are many different nationalities in the Soviet Union. Some live in the north and wear fur coats, hats, and boots many months of the year. Then there are those who wear long silk robes all year round, because it is so warm in their part of the country.

Every nationality sends its best people to the Supreme Soviet to discuss all matters of state: whether the work is proceeding according to plan, whether there were many new factories, electric power stations, railways, apartment houses, schools, and libraries built during the year. They talk about people like you too, and want to know how the children in the schools studied during the year, how many books were published, and how many note-books, pens, and pencils were made. After they have discussed all this, the delegates begin to consult each other on how to plan the future work. They discuss building projects, the rivers that have to be connected by canals, the sites of new forest belts, and irrigation canals in the desert.

Everything is decided wisely, to make sure that the affairs of the country are in order and that the working and living conditions of the people have been improved.

The plans are adopted for five years ahead, for there are many jobs that cannot be finished in a year, but there is also a yearly plan.

While working according to a common plan and building new houses and factories, the Soviet people are also building a new and better life.